Rare Plant Surveys on Fort Carson 2006-2007

Prepared for:
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Cover photograph: Fort Carson ridgeline
Photo taken by David G. Anderson.

EXECUTIVE SUMMARY

The Colorado Natural Heritage Program (CNHP) performed field surveys and rare plant mapping for five select sensitive plant species at Fort Carson: dwarf milkweed (*Asclepias uncialis* ssp. *uncialis*), round-leaf four-o'clock (*Mirabilis rotundifolia*), Arkansas Valley evening primrose (*Oenothera harringtonii*), Pueblo goldenweed (*Oonopsis puebloensis*), and Arkansas River feverfew (*Parthenium tetraneuris*). The species selected are among the Colorado Species of Special Concern identified by Fort Carson and some are on the list of Species at Risk on Department of Defense (DoD) installations. These plant species are rare throughout their range but are not listed or candidates for listing under the Endangered Species Act. Proactive management and conservation of these species may help preclude the need for listing. The information provided by mapping locations of rare plant species will facilitate natural resource planning at the installation. It will also inform rare plant protection in the Arkansas River Valley in partnership with several other agencies and organizations.

Fort Carson is a 138,303 acre (55,790 ha) military training installation south of Colorado Springs at the southern end of the Front Range. The installation spans the ecological transition zone from the foothills of Pikes Peak to the level ground of the Colorado Piedmont. Fort Carson has a series of low hogbacks and mesas supported by a series of Late Cretaceous sedimentary bedrock that is well-known for harboring rare plant species, several of which are nearly endemic to the small geographic area between Fort Carson, Cañon City, and Pueblo.

Following Natural Heritage methodology, approximately 5,700 acres were surveyed targeting the sedimentary bedrock exposures at the south end of Fort Carson. Twenty-nine CNHP element occurrences were updated and seventeen new occurrences were found. Fort Carson is at the north end of a significant landscape highlighted in the Rare Plants of the Chalk Barrens Potential Conservation Area.

Fort Carson contains many occurrences of plant Species of Special Concern and DoD Species at Risk, some of which represent the highest quality locations known for these species in the world. Thus the management of these species at Fort Carson will be important for the overall rangewide survival of these species. Species for which Fort Carson has significant management responsibility and potential for impact include:

- **Round-leaf four-o'clock (*Mirabilis rotundifolia*)**: Fort Carson contains 45 percent of the known occupied acres and 49 percent of the acreage occupied by the high quality plant occurrence acreage
- **Arkansas River feverfew (*Parthenium tetraneuris*)**: Fort Carson contains 44 percent of the known occupied acres of Arkansas River feverfew, and 45 percent of the high quality plant occurrence acreage

Species for which Fort Carson has a lower responsibility and potential for impact include:

- Dwarf milkweed (*Asclepias uncialis* ssp. *uncialis*)

- Arkansas Valley evening primrose (*Oenothera harringtonii*)
- Pueblo goldenweed (*Oonopsis puebloensis*)

The rare plant mapping that resulted from these field surveys will facilitate natural resource planning at Fort Carson and has provided valuable data about these important elements of biodiversity.

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INTRODUCTION

The Colorado Natural Heritage Program (CNHP) performed field surveys and rare plant mapping for five select sensitive plant species at Fort Carson (Table 1). Similar surveys were performed on the Piñon Canyon Maneuver Site (Neid et al. 2007). The species selected for these efforts are among the Colorado Species of Special Concern found on Fort Carson (Gene Stout and Associates 2007) and some are on the list of Species at Risk on Department of Defense installations (Grunau et al. 2007, Groves et al. 2000). These plant species are rare throughout their range but are not federally listed or candidates for listing under the Endangered Species Act. Proactive management and conservation of these species may help preclude the need for listing and fulfill the mission of Fort Carson, which is to provide high quality military training. The information provided by mapping locations of rare plant species will facilitate natural resource planning at the installation. It will also inform rare plant protection in the Arkansas River Valley in partnership with several other agencies and organizations, *e.g.*, Shortgrass Prairie Partnership. The Arkansas River Valley has one of the highest concentrations of rare plant species in Colorado; there are 48 species of concern in this region, several of which are nearly endemic to the area (Spackman Panjabi 2004).

The target species (Table 1) were previously known from the southern portion of Fort Carson. Presence of the target species was documented, but little was contained in CNHP's Biotics database about the population size and condition of these species on Fort Carson. In concert with other efforts in southeastern Colorado, CNHP was contracted to perform two years of field survey (2006-2007). The work extended over two field seasons due to the variable expression of these species given climatic conditions; all the species respond to moisture and can exhibit dormancy or reduced flowering and growth in drought years. Conducting the work over two field seasons increased the chances of having at least one favorable year for these species. Primary areas targeted for field inventory were the shale barrens hogbacks and mesas in the southern half of Fort Carson, where the majority of suitable habitat for the target species occurs.

Table 1. Target species for field surveys at study site. Nomenclature follows PLANTS Database (USDA NRCS 2007) for global scientific name and common name and Weber and Whittman (2001) for state scientific name. See Appendix A for explanation of Natural Heritage Ranking System. Flowering period is from Spackman et al. (1997).

Global Scientific Name	State Scientific Name	Common Name	Global Rank	State Rank	Flowering Period
Asclepias uncialis ssp. *uncialis*	*Asclepias uncialis* ssp. *uncialis*	dwarf milkweed	G3G4 T2T3	S2	late April-May
Mirabilis rotundifolia	*Oxybaphus rotundifolius*	round-leaf four-o'clock	G2	S2	June
Oenothera harringtonii	*Oenothera harringtonii*	Arkansas Valley evening primrose	G2G3*	S2S3*	mid May-June
Oonopsis sp 1	*Oonopsis puebloensis*	Pueblo goldenweed	G1G2	S1S2	July
Parthenium tetraneuris	*Bolophyta tetraneuris*	Arkansas River feverfew	G3	S3	April-May

* Recent rank changes may not be reflected in NatureServe postings.

Regional setting

Fort Carson is a 138,303 acre (55,790 ha) military training installation at the southern end of the Front Range in central Colorado (Figure 1). It straddles El Paso, Pueblo, and Fremont counties. It is south of Colorado Springs; its northern end is just south of Highway 83, between Interstate 25 and Highway 115, which skirts the foothills of Pikes Peak to the west. The east border of Fort Carson follows an irregular line south from Fountain. The south border abuts ranchland in northwest Pueblo County, 6-7 miles south of the El Paso-Pueblo county line.

Fort Carson is at the ecotone of the mountains and plains; it is on the west edge of the high plains near their convergence with the Rocky Mountains in southeast Colorado. It is just below Pikes Peak north of the notch in the Rocky Mountain front formed by the Arkansas River and the Cañon City Embayment (Colorado Geological Survey 2003). Fort Carson spans the transition from the Foothills and Shrublands of the Southern Rocky Mountains to the irregular and dissected plains of the Piedmont Plains and Tablelands subsections (Figure 2; Chapman et al. 2006). Between these subsections is a narrow band of Pinyon-Juniper Woodland that occurs on Fort Carson. The moderate to high gradients of the foothills of Pikes Peak transition to shale and limestone hogback ridges and mesas that underlie the sparser Pinyon-Juniper Woodlands before flattening out onto the plains. Elevation on Fort Carson ranges from 5200 feet (1585m) at Beaver Creek in the southwest corner of Fort Carson to 6896 feet (2102m) on Timber Mountain. Terrain generally slopes down in elevation from the northwest to southeast. Lowest points are the plains on the southern border between Pierce Gulch as well as the broad, flat drainage of Young Hollow on the east side of the installation. Highest areas include Timber Mountain, Booth Mountain, and the sharp hogback above Deadman Canyon along Highway 115 southwest of Rock Creek Park.

Climate

Average annual precipitation at Fort Carson is 14.3 inches (36.2cm). More than eighty percent of this precipitation falls between April and September (WRCC 2007). Thunderstorms are common in the mid- to late summer as wind patterns often shift to more southerly directions providing monsoonal moisture to convection storms (Doesken et al. 2003). Colorado's eastern plains have only recently emerged from severe drought conditions. Although drought conditions have ameliorated in the last few years, with record monsoonal moisture in July and August of 2006 and record snow totals in the winter of 2006-2007, the last three years have been among the hottest summer temperatures on record (NOAA 2007).

Geology

Bedrock geology is influenced by the proximity of Fort Carson to the Rocky Mountain front, its uplift and subsequent erosion. The uplift of the mountains tilted and fractured the Mesozoic (Triassic, Jurassic, and Cretaceous) sedimentary layers (Morgan et al. 2006). Subsequent erosion uncovered what is now granitic Pikes Peak and formed a series of hogbacks that expose the various older sedimentary layers such as the Fountain

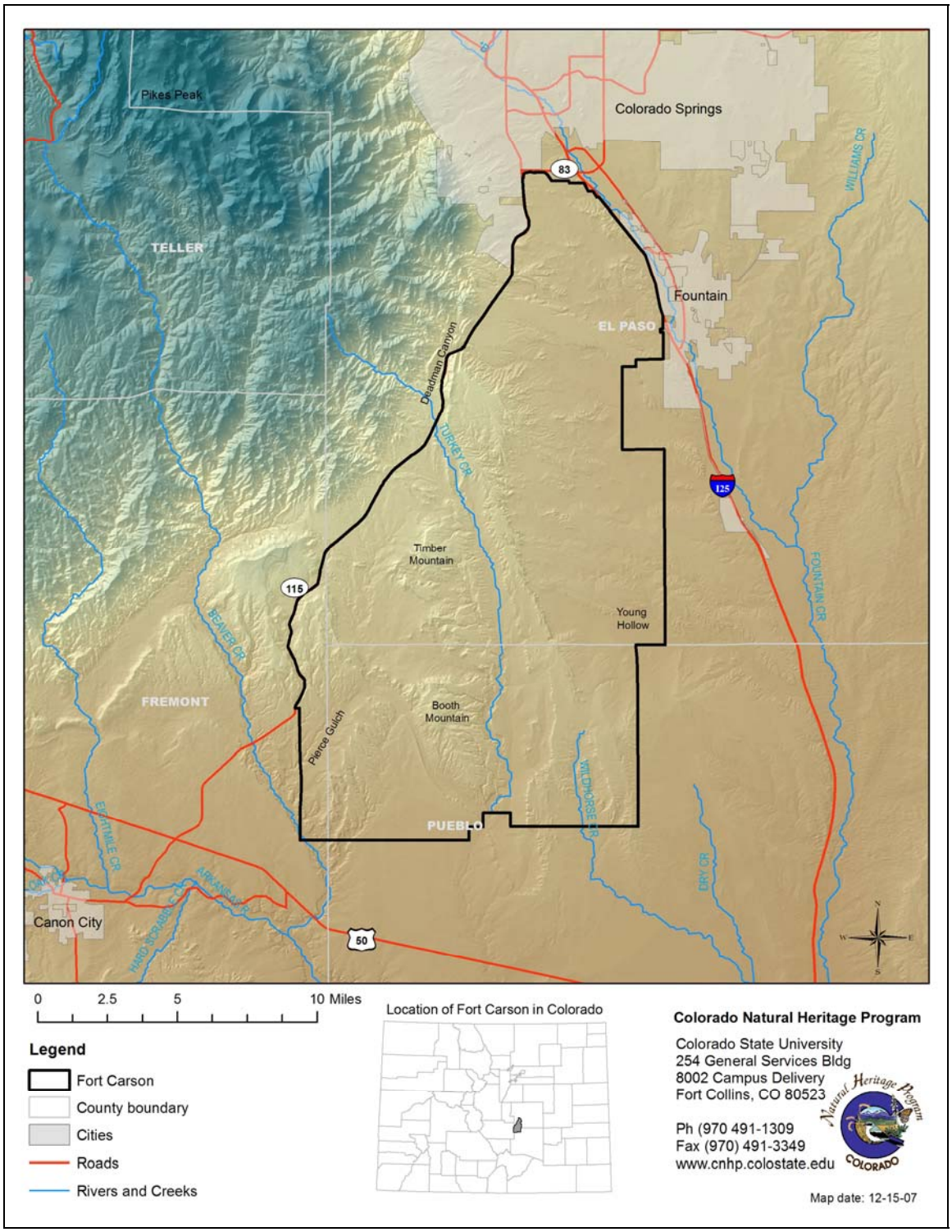

Figure 1. Regional setting of Fort Carson in Colorado.

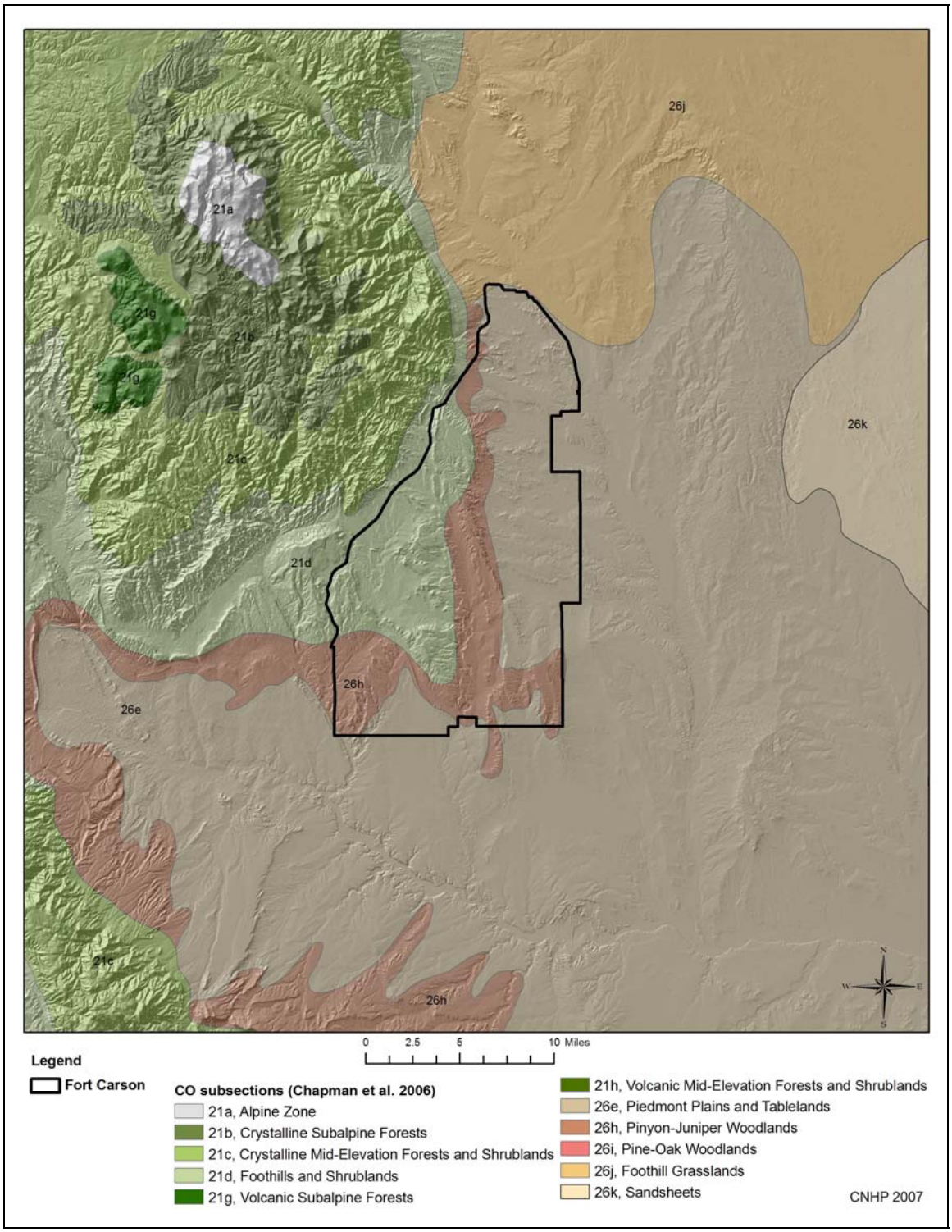

Figure 2. Ecological subsections (Chapman et al. 2006) in the vicinity of Fort Carson.

and Morrison Formations, Lyons and Dakota sandstones, and the Purgatoire Formation. These are represented by sandstone dominated formations and siltstone and mudstone dominated formations (USGS GAP Analysis Program 2004) in Figure 3 (see also Table 2). Abutting these older hogbacks are a series of lower shale ridges and mesas of various Late Cretaceous sedimentary layers (displayed as shale dominated formations in Figure 3)—a composite of Carlile shale, Greenhorn limestone, and Graneros shale—before the low relief plains underlain by the Niobrara Formation (carbonate dominated formations).

Late Cretaceous bedrock forms the shale hogbacks, mesas, and large outcrops in the southern portion of Fort Carson. This bedrock consists of layer upon layer of shales, chalks, and limestones originating from the vast inland seas that covered the interior of the continent during that Period (Scott and Cobban 1964). The series of sedimentary layers is well-described in this region (Scott 1964, Scott 1969) and their relationship to plant distribution is summarized in Kelso et al. (1999, 2003). Layers exposed on Fort Carson include (from older to younger) Graneros shale, Greenhorn limestone, Carlile shale, and Niobrara Formation, with the latter two forming the majority of underlying bedrock and exposed outcrops. Carlile shale is split into various shale and sandstone members with calcerinite as a unique and notable mineral (Scott 1964). The Niobrara Formation is a larger series of calcareous shale, limestone, and chalk layers with bentonite, gypsum, and selenium components in varying proportions. Important Members within the Niobrara Formation include Fort Hays sandstone and Smoky Hills shale, the latter of which is divided into eight units with shale and limestone below alternating layers of chalk and shale (Scott 1964, Scott and Cobban 1964). Where the shale and chalk layers are exposed, they tend to form barrens with little soil development. The rare endemic plant species often occur at the interface of several sedimentary layers, especially at interfaces within the middle and upper chalk units of the Smoky Hills member of the Niobrara Formation and those between Fort Hays and Carlile shales.

Soils

In the rainshadow of the Rocky Mountains where Fort Carson is located, calcification is the predominant soil forming process (Bailey 2001). Soils tend to be rich in base ions and precipitated calcium carbonate because climate conditions are too dry to leach the ions from the top horizons. Soils are primarily a function of topography and bedrock geology at Fort Carson. Shallower, rockier soils occur on ridges, breaks, hogbacks, and foothills and deeper, finer-textured soils occur on the plains. Soil mosaics of various textures occur in drainages (Larsen et al. 1979).

Soils in the southern portion of Fort Carson are a mosaic of Manvel silt loam on mesas and plains and Penrose-Minnequa and Penrose-rock outcrop complexes on the ridges and dissected drainages that have eroded through the underlying limestone and shale bedrock (Larsen et al. 1979). Manvel soils are deep silt loams with slow permeability and high available moisture. Erosion hazard is moderate in these soils. The Penrose-Minnequa complex occurs on shoulder slopes and the sideslopes of drainages and escarpments. These soils are very shallow to bedrock (usually only 10-12 inches deep) and have a very high proportion of rock fragments in the limited loam and silt loam matrix. In the southeast portion of Fort Carson, the plains have inclusions of Kim soils in the mosaic.

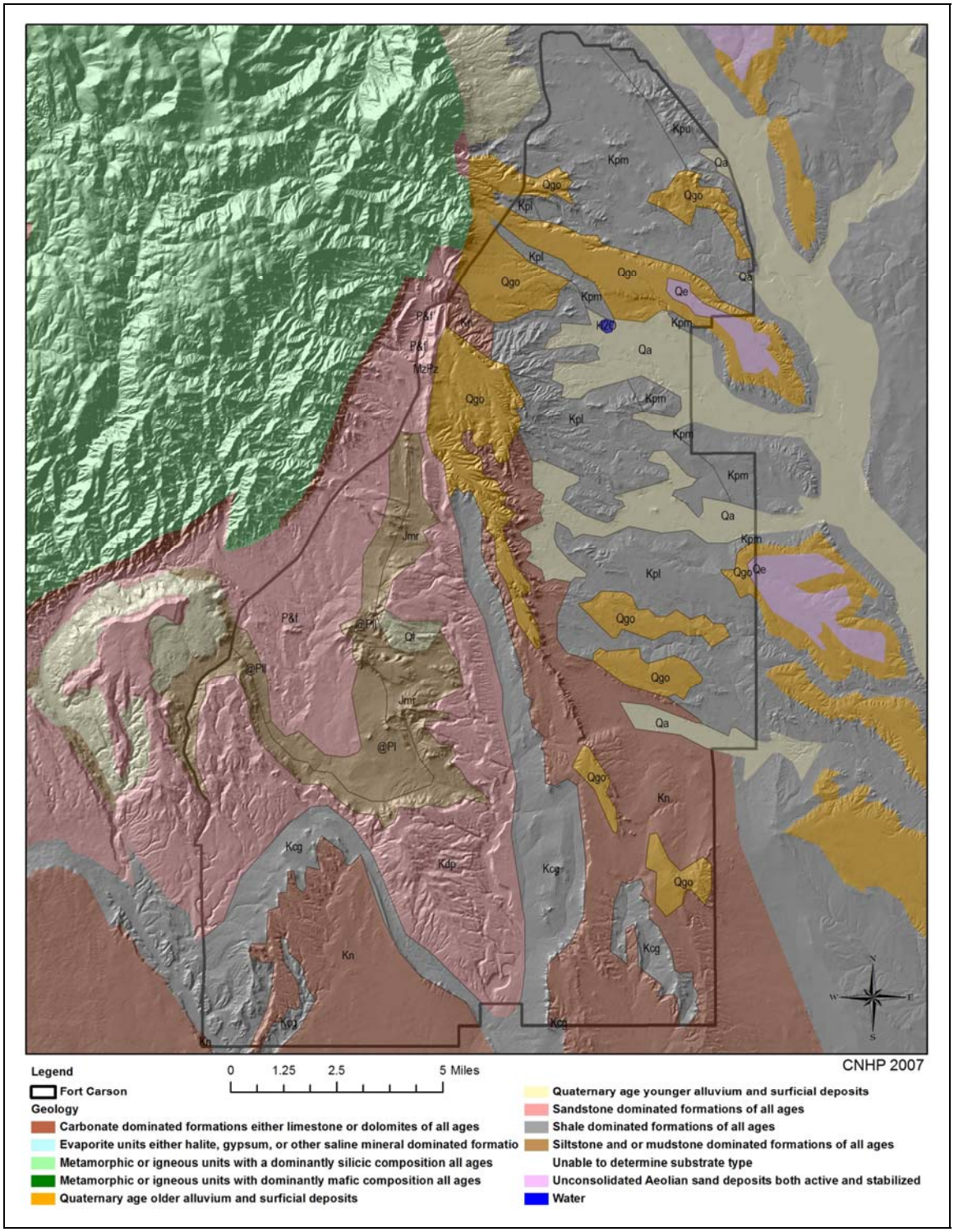

Figure 3. Geology of Fort Carson (USGS GAP Analysis Program 2004). See also Table 2.

Table 2. Descriptions of geologic units shown in Figure 3. Code and name/description is from Tweto (1979) and SW ReGAP substrate and group are from USGS GAP Analysis Program (2004).

Code	Name and description	SW ReGAP Substrate	SW ReGAP Group
@Pl	LYKINS FORMATION--Red siltstone, shale, and limestone	Siltstone and or mudstone dominated formations of all ages	Sedimentary rocks of Triassic age
@Pll	LYKINS FORMATION AND LYONS SANDSTONE	Siltstone and or mudstone dominated formations of all ages	Sedimentary rocks of Triassic age
H2O		Water	
Jmr	MORRISON FORMATION AND RALSTON CREEK FORMATION (CLAYSTONE, SANDSTONE, LIMESTONE, AND GYPSUM)	Siltstone and or mudstone dominated formations of all ages	Sedimentary rocks of Jurassic age
Kcg	CARLILE SHALE, GREENHORN LIMESTONE, AND GRANEROS SHALE	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kdp	DAKOTA SANDSTONE AND PURGATOIRE FORMATION--Sandstone and shale	Sandstone dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kn	NIOBRARA FORMATION--Calcareous shale and limestone	Carbonate dominated formations either limestone or dolomites of all ages	Sedimentary rocks of Cretaceous age
Kpl	PIERRE SHALE, Lower unit--Sharon Springs Member (organic-rich shale and numerous bentonite beds) in lower part	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kpm	PIERRE SHALE, Middle unit--In Boulder-Fort Collins area, contains Richard, Larimer, Rocky Ridge, Terry, and Hygiene Sandstone Members; elsewhere, shale between zones of *Baculites reesidei* and *B. scotti*	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
Kpu	PIERRE SHALE, Upper unit	Shale dominated formations of all ages	Sedimentary rocks of Cretaceous age
MzPz	MESOZOIC AND PALEOZOIC ROCKS--Mainly as in Mesozoic unit (Mz) plus Permian and Pennsylvanian formations	Sandstone dominated formations of all ages	Sedimentary rocks of Cretaceous age
P&f	FOUNTAIN FORMATION--Arkosic sandstone and conglomerate	Sandstone dominated formations of all ages	Sedimentary rocks of Permian and Pennsylvanian age
Qa	MODERN ALLUVIUM--Includes Piney Creek Alluvium and younger deposits	Quaternary age younger alluvium and surficial deposits	Unconsolidated surficial deposits and rocks of Quaternary age
Qe	EOLIAN DEPOSITS--Includes dune sand and silt and Peoria Loess	Unconsolidated Aeolian sand deposits both active and stabilized	Unconsolidated surficial deposits and rocks of Quaternary age
Qgo	OLDER GRAVELS AND ALLUVIUMS (PRE-BULL LAKE AGE)--Includes Slocum, Verdos, Rocky Flats, and Nussbaum Alluviums in east, and Florida, Bridgetimber, and Bayfield Gravels in southwest	Quaternary age older alluvium and surficial deposits	Unconsolidated surficial deposits and rocks of Quaternary age
Ql	LANDSLIDE DEPOSITS--Locally includes talus, rock-glacier, and thick colluvial deposits	Quaternary age younger alluvium and surficial deposits	Unconsolidated surficial deposits and rocks of Quaternary age

Kim fine sandy loam is represented by deep, well-drained pockets over bedrock containing gypsum. There are minor amounts of other soil types including several silty clay loams (Shingle, Haverson, Heldt, Cascajo), silty clays (Midway) and clays (Razor) that form mosaics in stream drainages that are frequently subject to brief flooding with precipitation events. The majority of soils in the targeted inventory areas at Fort Carson are calcareous and moderately to strongly alkaline.

Vegetation

Vegetation at Fort Carson is patterned according to elevation and topography on the installation. Hills at higher elevations are primarily comprised of pinyon-juniper woodlands (*Pinus edulis – Juniperus monosperma*) typical of foothills habitat in this area. It often has a variable shrub component with gambel oak (*Quercus gambelii*) and/or mountain mahoghany (*Cercocarpus montanus*) over a moderately sparse understory. Relatively flat areas at the lower elevations are grasslands that establish in the deeper soils. The grassland mosaic has elements of shortgrasses such as grama grasses (*Bouteloua* spp.), and midgrasses such as galleta (*Pleuraphis jamesii*) and western wheatgrass (*Pascopyrum smithii*). There is a diverse forb component and occasional shrubs, *e.g.*, saltbush (*Atriplex canescens*), rabbitbrush (*Chrysothamnus nauseosus*), or yucca (*Yucca glauca*) that may sporadically occur. Intervening shale hogbacks support a unique mosaic of shale barrens plant communities that include shrublands with frankenia (*Frankenia jamesii*) and/or Bigelow sagebrush (*Artemisia bigelovii*), with or without a pinyon-juniper canopy. Fourwing saltbush (*Atriplex canescens*) is also common in finer-textured soils. The unifying feature of these barrens is sparse vegetation cover within the limited soils beneath a pavement of platy shale fragments. There is also a characteristic suite of herbaceous plants adapted to shallow, droughty, low-nutrient soils (Kelso et al. 1999). Many of these species are low-growing cushion plants such as woollycup buckwheat (*Eriogonum lachnogynum*), nailworts (*Paronychia jamesii, P. sessiliflora*), stemless four-nerve daisy (*Tetraneuris acaulis*), bladderpods (*Lesquerella* spp.), and Arkansas River feverfew (*Parthenium tetraneuris*) and grasses including New Mexico feathergrass (*Hesperostipa neomexicana*), galleta, and Indian ricegrass (*Achnatherum hymenoides*).

The target species for this report occupy distinct habitat niches. Arkansas River feverfew and round-leaf four-o'clock (*Mirabilis rotundifolia*) are shale barrens endemics and occur on the sparsely vegetated shale outcrops and hogbacks. Pueblo goldenweed (*Oonopsis puebloensis*) and Arkansas Valley evening primrose (*Oenothera harringtonii*) occur in finer textured soils and tend to concentrate at toeslopes, on sideslopes, and in landscape swales, often below the hogback ridges that support Arkansas River feverfew and round-leaf four-o'clock. Habitat of dwarf milkweed (*Asclepias uncialis* ssp. *uncialis*) is primarily grasslands, especially at the interface with pinyon-juniper woodlands. Habitats occupied by the target species are extensive on Fort Carson.

METHODS

CNHP staff performed field surveys at targeted inventory areas at Fort Carson throughout the field seasons of 2006 and 2007. Field surveys were scheduled as closely as possible to correspond with the phenology of the targeted rare plant species (see Table 1) but with regard to military training activities on the installation. Field surveys were scheduled for May, June, and July. Additionally, field surveys occurred in September of 2006 in response to climatic conditions during the growing season that favored late emergence of certain target species (*e.g.*, round-leaf four-o'clock). Known locations of target species were revisited at Fort Carson. Additionally, CNHP focused on habitats with the greatest probability for harboring rare species, *i.e.*, rock outcrops, sand washes, roadsides. Search areas were targeted using aerial photos and topographic and geology maps to survey each area as completely as possible and to maximize the likelihood of finding additional occurrences. Surveys were conducted by hiking and driving through portions of each inventory area, examining unusual topographic or edaphic features as well as typical habitat at the sites.

When rare plants were encountered, data were collected following Natural Heritage Methodology (NatureServe 2006, Appendix A). Data collected using this methodology included location information, plant population parameters, and habitat characteristics. Location data were collected as GPS coordinates or were depicted on topographic maps or aerial photos from which a legal description (township, range, and section) can be determined. Data collected on plant populations included occurrence size and condition parameters. Abundance was determined by censusing the occurrence or by estimating the number of individuals if the population was large. Size of the area covered by the population was also estimated or calculated using GIS. Condition of plant populations was assessed by data collected on phenology (percent of the plants that are vegetative, percent in flower, and percent in fruit at the time of survey); reproductive success (evidence of seed dispersal and establishment); age class structure; symbiotic or parasitic relationships (*e.g.*, pollinators present); and evidence of disease, predation or injury. Habitat information collected included descriptions of the surrounding landscape, dominant plant community or associated plant species, elevation, topographic position, slope, shape of slope, aspect, light exposure, soil texture, moisture gradient, and geomorphic landform.

In addition to data characterizing the species population and its habitat, information was collected to evaluate the likelihood of continued existence of the plant population at the location as well as the means of increasing the viability and recoverability. The occurrences were ranked according to a system that incorporates size, condition/quality, and landscape context (Appendix A). Such information can assist with management of the areas by identifying threats and natural or unnatural disturbance (*e.g.*, effects on population viability due to mining, recreation, grazing, and/or exotic species). The information gathered also referred to any protection plans or strategies that are in place for the species or for a location. Herbarium voucher specimens were collected and deposited in Colorado herbaria for new occurrences when the population size was sufficient to support collecting. Where population size was insufficient, photographs of diagnostic characters were taken.

Field survey results were incorporated into existing information in the CNHP Biotics database (element occurrence records, plant characterization abstracts, global ranking forms, and Potential Conservation Areas) to augment the comprehensive picture of the global distribution, habitat requirements, and threats to rare plant species encountered.

RESULTS AND DISCUSSION

The area surveyed at Fort Carson is shown in Figure 4. In 2006, approximately 3,700 acres were surveyed at Fort Carson for target species and approximately 2,000 acres were surveyed in 2007. CNHP staff visited Fort Carson in early July 2006 under drought conditions, which confounded the search for certain targeted rare plant species, especially those that typically flower early in the growing season (see Table 2). Spring moisture was negligible in 2006; less than one inch of rain fell in both May and June. Conditions did not ameliorate until late June and early July when record monsoon precipitation began to fall. Fort Carson was revisited in late July and in early September following the extensive summer rains, which brought up many of the target species not visible previously during the drought. Temperatures were above average during the entire 2006 growing season, from April to September. Precipitation was average in 2007 during the primary survey periods in the early growing season. Although below normal levels of precipitation occurred after June, this largely did not impact the emergence and flowering of target species in 2007. Field surveys occurred in May and July of 2007.

New locations were found for all of the target species and most of the previously known element occurrence record locations were evaluated. In addition to the target species, new occurrences of Rocky Mountain bladderpod (*Lesquerella calcicola*; G2/S2) and Fendler's Townsend daisy (*Townsendia fendleri*; G2/S1) were discovered on Fort Carson. Golden blazingstar (*Mentzelia chrysantha*; G2/S2) was observed in 2006 and 2007 at known locations for this species. Species that were not on the target list were found incidentally during the surveys. However, they were not systematically searched for and mapped on Fort Carson. Table 3 lists the element occurrence records for rare species tracked by CNHP found on Fort Carson. A total of 29 element occurrences were updated and 17 new records were found.

Acreage of element occurrences for target species and other plant species tracked by CNHP at Fort Carson following the 2006-2007 field surveys are listed in Table 4. Geographic range in Colorado was determined by calculating the area of a minimum convex polygon around all mapped occurrences for the species in the CNHP Biotics database (CNHP 2007). Total rangewide acres and occupied acres were calculated from all element occurrence records for the species in the CNHP Biotics database with precise location information. Percent of high quality (A- and B-ranked) occurrences was calculated from the total acreage of all high quality occurrences in Colorado.

All rare species mapped on Fort Carson comprise a total of 2,850 acres (including non-target plant species). Fort Carson contains a significant portion of the total rangewide acreage of round-leaf four-o'clock (*Mirabilis rotundifolia*), Arkansas River feverfew (*Parthenium tetraneuris*), and golden blazingstar (*Mentzelia chrysantha*) with similar percentage of acreage occupied by high quality occurrences (Table 4).

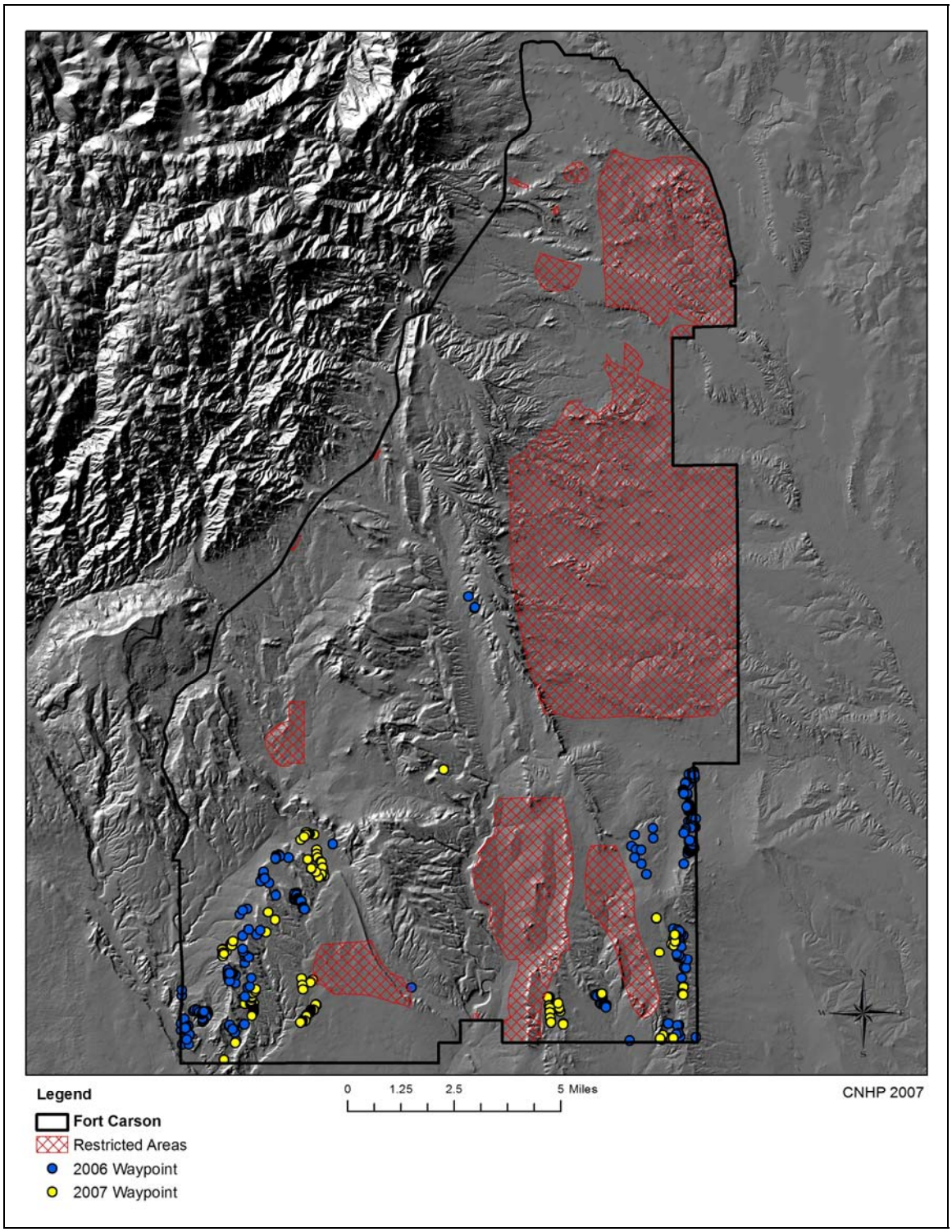

Figure 4. Areas surveyed on Fort Carson 2006-2007.

Table 3. Element occurrence (EO) records at Fort Carson. See Appendix A for explanation of EO Ranking System.

Species Name	EO number	EO rank	Notes
TARGET SPECIES			
Asclepias uncialis ssp. *uncialis*	039	C	Size and condition updated to re-rank EO from E to C.
Mirabilis rotundifolia	020	A	Size and condition updated and new locations mapped. Occurrence is shared with adjacent private landowner
	021	B	Size and condition updated and new locations mapped.
	023	A	Size and condition updated and new locations mapped. Occurrence shared with adjacent private landowner
	025	D	Last observed in 1995; searched for and not found in 2006
	026	D	Last observed in 1995
	029	B	Size and condition updated and new locations mapped.
	031	B	Size and condition updated and new locations mapped.
	032	A	Size and condition updated and new locations mapped.
Oenothera harringtonii	041	AB	New record found in 2006. New locations added in 2007.
	042	A	New record found in 2006. New locations added in 2007.
	045	BC	New record
	046	B	New record
	047	B	New record
Oonopsis puebloensis	019	A	New record from 2005 data. Size and condition updated and new locations mapped in 2006-2007. Will be combined with #020 in the future (Handwerk pers. comm.).
	020	A	New record from 2006. Size and condition updated and new locations mapped in 2007. Will be combined with #019 in the future (Handwerk pers. comm.). Occurrence shared with adjacent private landowner.
	021	A	New record
	023	C	New record
	024	C	New record
	025	C	New record
Parthenium tetraneuris	006	C	Last observed in 1998; occurrence shared with adjacent private landowner
	033	B	Size and condition updated and new locations mapped to re-rank EO from an A to a B. Occurrence shared with adjacent private landowner.
	034	C	Size and condition updated and new locations mapped.
	035	BC	Size and condition updated and new locations mapped.
	036	BC	Size and condition updated and new locations mapped to re-rank EO from E to BC
	037	B	Size and condition updated and new locations mapped to re-rank EO from C to B. Occurrence shared with adjacent private landowner.
ADDITIONAL TRACKED SPECIES ON FORT CARSON			
Mentzelia chrysantha	027	C	Size and condition updated and new locations mapped.
	030	B	New record from 2005 data. Size and condition updated and new locations mapped in 2006-2007. Occurrence shared with adjacent private landowner
	031	D	Size and condition updated and new locations mapped.
	032	BC	Size and condition updated and new locations mapped.

Table 4. Areal statistics for rare plant species at Fort Carson.

Plant species	Geographic range in Colorado (sq mi)	Total acres known in Colorado	Occupied acres on Fort Carson	Percent of total Colorado acres occurring on Fort Carson	Percent of high quality (A- and B-ranked) occurrences on Fort Carson
Asclepias uncialis ssp. *uncialis*	27,785	406	9	2.2	0
Mirabilis rotundifolius	1441	2636	1191	45.2	48.6
Oenothera harringtonii	6059	2146	132	6.1	19.4
Oonopsis puebloensis	349	2320	209	9.0	9.1
Parthenium tetraneuris	unknown	2753	919	43.9	45.3
Mentzelia chrysantha	530	1227	336	27.4	30.5

Fort Carson is at the north end of a significant landscape characterized by extensive outcrops of Late Cretaceous sedimentary bedrock. The Cañon City – Pueblo - Fort Carson area contains the highest concentration and extent of shale and limestone outcrops in Colorado and harbor several rare and endemic plant species (Kelso et al. 2003). Occurrences are strongly correlated with shale bedrock (mapped as undifferentiated Graneros, Carlile, Greenhorn; Tweto 1979) especially at the contact areas between sedimentary layers. These landscape features are highlighted in the Rare Plants of the Chalk Barrens Potential Conservation Area (PCA), which extends from the Cañon City embayment, the landscape-scale basin surrounding Cañon City, east-southeast along the Arkansas River to Pueblo, and northeast along the Rocky Mountain front to Fort Carson (Appendix B). This PCA has the highest biodiversity rank, outstanding biodiversity significance (B1; see Appendix A), assigned for the high concentration of rare plant species and the vast number of occurrences. The PCA contains 103 occurrences of eight rare plant species, including the five target species—dwarf milkweed (4 occurrences), round-leaf four-o'clock (25 occurrences), Pueblo goldenweed (17 occurrences), Arkansas Valley evening primrose (13 occurrences), and Arkansas River feverfew (24 occurrences)—as well as golden blazingstar (13 occurrences), Rocky Mountain bladderpod (6 occurrences), and Fendler's Townsend-daisy (1 occurrence). Fort Carson contains several of the high quality occurrences of these rare species, especially round-leaf four-o'clock, Pueblo goldenweed, Arkansas River feverfew, and golden blazingstar, which will be discussed below in the Species Accounts section.

SPECIES ACCOUNTS

Dwarf milkweed *(Asclepias uncialis* ssp. *uncialis)*; Milkweed Family (Asclepiadaceae)

Dwarf milkweed (Photo 1) is a small (1-2.5 inch), long-lived perennial herb with approximately 35 known extant occurrences in fourteen counties in Colorado (CNHP 2007). It also occurs in limited areas of New Mexico and Arizona (Decker 2006). The majority of the Colorado occurrences are in southeast Colorado. This species is presumed to be in decline. It was collected much more frequently in Colorado 100 to 150 years ago by early botanical explorers and many of these historically known locations no longer support occurrences of the species (Locklear 1996).

Photo 1. Dwarf milkweed (*Asclepias uncialis* ssp. *unicialis*). Photo by Dave Anderson.

In Colorado, dwarf milkweed occurs in shortgrass prairie habitat often at the interface with juniper savanna and juniper breaks habitat. Plants also occur at toeslopes of bluffs, on slope crests, and in somewhat featureless open grassland habitat. At Fort Carson it occurs in grassland habitat dominated by New Mexico feathergrass (*Hesperostipa neomexicana*), blue grama (*Bouteloua gracilis*), and purple threeawn (*Aristida purpurea*) and on Wiley-Kim soils. The areas are near roads and near juniper savanna. Although its geographic range within Colorado is extensive (27,785 square miles on the eastern plains), the actual known occupied area is very small, only 406 acres (Table 4). Further, the vast majority of occurrences are understood to have small population sizes, with only three having greater than 100 individuals. Current population sizes may also be over-estimates. Dwarf milkweed is semi-rhizomatous with extensive underground biomass; root crowns extend 10-12 inches below ground and can exhibit extensive branching (see photos in Decker 2006). Thus, clusters of stems that emerge within a certain distance are likely to be from a single root stalk and comprise one individual, making population census difficult. Population size of the occurrence at Fort Carson is small, with only five individuals observed in 2007.

Threats to dwarf milkweed listed in Decker (2006) include effects of population limitation by unknown biological requirements, altered disturbance regime, habitat loss, and habitat degradation. At Fort Carson, habitat degradation or loss are likely the most pertinent as well as the lack of life history information to inform land management

decisions for this species. Little is known about the life history of dwarf milkweed, which exacerbates attempts to abate or mitigate threats to it. Information on demographics, pollination ecology, and response to disturbance (both natural and anthropogenic) would inform land management decisions that include dwarf milkweed. Given the lack of information, a conservative strategy for defining appropriate management practices would include activities that maintain intact native habitat (free of exotic species, predominated by natural ecological processes) in and around occurrences. As many individual occurrences are at the savanna-grassland ecotone, successional status of adjacent woodland habitat may be important and maintaining a natural disturbance regime may be beneficial to known occurrences. Mature dwarf milkweed plants have a demonstrated ability to tolerate certain amounts of disturbance. However, this species is not found in more dynamic habitats, thus activities that cause more severe disturbance (*i.e.*, deep soil disturbance) will likely damage or kill plants (Decker 2006). Proactive weed management that prevents invasion of known occupied areas is preferable to weed treatment within occurrences, as dwarf milkweed itself is susceptible to herbicide spraying.

Fort Carson contains only a small portion of the known occupied areas of dwarf milkweed (Table 4). However, continuing inventory efforts and establishing population monitoring will contribute to our understanding of whether the species is truly in decline, or whether current population demographics are within its historical range of variability. Due to its diminutive size and relatively brief appearance during the growing season, it is somewhat difficult to detect; proper training in identification of dwarf milkweed and careful attention to its phenology will be the most beneficial in targeting survey efforts. CNHP element occurrence information would provide baseline data for analyzing trends and informing management.

Round-leaf four-o'clock (*Mirabilis rotundifolia*); Four-o'clock Family (Nyctaginaceae)

Round-leaf four-o'clock (Photo 2) is a narrowly endemic species occurring primarily between Cañon City, Fort Carson, and Pueblo, but with a disjunct occurrence in Las Animas County. It is restricted to shale barren habitat between 4,800-5,600 feet. It is primarily found on the Smoky Hill shale member of the Niobrara Formation; although there are several occurrences noted from Carlile and Pierre shales (CNHP 2007). At Fort Carson, round-leaf four-o'clock is found on Niobrara Formation. It is currently known from approximately 30 distinct locations, eight of which are on Fort Carson (Table 3), within a relatively small (1,440 square mile) geographic range. Within its geographic range it only occupies approximately 2,636 acres, 1,191 of which are on Fort Carson (Table 4). It exhibits a wide range of population size, from less than ten plants to several thousand stems, but most commonly occurs in the range of hundreds of individuals. Occurrence sizes at Fort Carson range from 12 to 2,787 plants. However, round-leaf four-o'clock is also a perennial herb species from a thick, woody, starchy root stalk with prolific lateral branching (Heckman 1997). Thus, it is difficult to identify the full extent of a single individual, which may lead to an over-estimation of population size. Further, it is demonstrably variable in response to climatic conditions; plant numbers, plant size, and number of flowers vary considerably with precipitation. Individuals are also able to

sustain prolonged dormancy during unfavorable conditions. When round-leaf four-o'clock flowers early in the growing season, its flowers open before dawn and close by mid-morning. This species has a low specificity of pollinators (Spackman Panjabi 2004). Among shale barrens species, round-leaf four o'clock is relatively more susceptible to severe disturbance such as road building, mining, or motorcycle traffic (Kelso et al. 1999, CNHP 2007). It does not tend to occur on road cuts although is known from areas adjacent to roads that were not impacted by their construction. It is able to tolerate and actually increases in total stem number under a moderate level of disturbance such as foot traffic (Kelso et al. 1999). Pesticide use in the vicinity of the occurrences may impact both individual plants and their pollinators (Spackman Panjabi 2004).

Known occurrences of round-leaf four-o'clock at Fort Carson include some of the best in the world. They occur on shale breaks habitat on Penrose soils. There are five extensive occurrences on Fort Carson, two of which are shared with adjacent private landowners. Fort Carson manages 45 percent of the known occupied acres of round-leaf four-o'clock. Of the highest quality occurrences (A- or B-ranked), Fort Carson contains 49 percent of the acreage occupied by all high quality records.

Arkansas Valley evening primrose (*Oenothera harringtonii*); Evening Primrose Family (Onagraceae)

Arkansas Valley evening primrose (Photo 3) is an insect-pollinated annual or biennial herb with a thick taproot (Ladyman 2005). Its flowers open in the evening and are pollinated by sphinx moths (Spackman Panjabi 2004). It is endemic to south-central Colorado known from approximately 50 extant occurrences in seven counties (CNHP 2007). Its geographic range within the state is 6,059 square miles, but it is unevenly distributed within this total area, occupying only 2,146 acres (Table 4). Although an annual or biennial this species is known to persist at certain sites for decades (Ladyman 2005). It is also very responsive to annual precipitation. Previously documented population sizes ranging from less than ten to hundreds of individuals exhibited two to four times as many plants in 2007 following high moisture in the late 2006 season and winter 2006-2007 (CNHP 2007). Arkansas Valley evening primrose is a prolific seed producer (Ladyman 2005) as is typical of plants with short annual or biennial life cycles.

Arkansas Valley evening primrose is generally found in compacted, silty clay soils derived from shale bedrock, including Niobrara Formation, and Carlile and Pierre shales. At Fort Carson it is associated primarily with Niobrara Formation and more infrequently with Carlile shale. Arkansas Valley evening primrose tends to occur at toeslopes and on flats in landscape swales, although it does colonize slopes that can be somewhat steep. Arkansas Valley evening primrose also tends to occur on roadsides adjacent to occupied shale barrens, opportunistically colonizing the disturbed habitat. It tends to occur in relatively high numbers along roadsides. These sorts of habitats imply that Arkansas Valley evening primrose is adapted to some mild degree of small-scale disturbance, such as processes of deposition and of shrink-swell cycles in clay soils, more so than to larger scale, more intensive disturbance.

Photo 2 (left). Round-leaf four-o'clock (*Mirabilis rotundifolia*). Photo by Georgia Doyle.
Photo 3 (right). Arkansas Valley evening primrose (*Oenothera harringtonii*). Photo by Stephanie Neid.

The five occurrences at Fort Carson (Table 3) include two with large numbers of plants and three with moderately small observed population sizes. They occur on Carlile shale and Niobrara Formation on sideslopes and toeslopes on Haverson, Heldt, Midway, and Shingle soils, especially those adjacent to Penrose-Minnequa complex. Of the 2,146 known occupied acres in Colorado, Fort Carson contains six percent of the total acres. However, Fort Carson supports 19.4 percent of the area occupied by high quality occurrences (Table 4).

Threats to Arkansas Valley evening primrose include any threats to the shale barrens habitat. At Fort Carson invasion by exotic species and deep soil disturbance are likely the most significant potential impacts to this species.

Pueblo goldenweed (*Oonopsis puebloensis*); Sunflower Family (Asteraceae)

Pueblo goldenweed (Photo 4) is an insect-pollinated perennial subshrub that is narrowly endemic to the Cañon City - Pueblo area. It is visited by a wide variety of insects although specific pollinators for Pueblo goldenweed are unknown (Spackman Panjabi 2004). It is known from 24 occurrences in Colorado; it occupies approximately 850 acres within a 350 square mile geographic range (Table 4). It occurs between 4,800-5,500 feet (CNHP 2007). Pueblo goldenweed was only recently identified as a distinct taxon in 1982 by Dr. G. Brown at the University of Wyoming. It is not described in the scientific literature and therefore is not yet recognized as a species (USDA NRCS 2007). Nonetheless, it is included in most ongoing conservation planning efforts (*e.g.*, The Nature Conservancy 2001). It is known from outwash deposits adjacent to Niobrara shale outcrops, especially the Smoky Hill shale member (CNHP 2007). Population sizes range from less than one hundred to thousands of individuals. It can colonize small washes or barren areas on toeslopes associated with shale bedrock and adjacent alluvium. It can be quite weedy when associated with roads, and tends to establish well in moderately disturbed roadside habitat.

Occurrences at Fort Carson occur on sideslopes and swales over Niobrara Formation in Shingle and Heldt soils as well as Penrose-Minnequa complex soils. There are currently six element occurrences of Pueblo goldenweed on the installation. Three of the Fort Carson occurrences rank among the best known occurrences for quality and size, exhibiting very large numbers of plants. Fort Carson contains nine percent of both the total known acreage and the high quality occurrence acreage for Pueblo goldenweed (Table 4). However, one of the high quality occurrences on Fort Carson shared with an adjacent private landowner is extensive (greater than 1,700 acres) and comprises approximately 80 percent of the known Colorado acreage for Pueblo goldenweed.

Threats to the species are largely unknown but assumed to include any threat to its shale barrens habitat. Due to its ability to colonize rapidly and occur in large numbers, this species is generally less threatened than other shale barrens species. However, until the dynamics of natural populations of this species are understood, monitoring impacts to all occurrences may be warranted. Pueblo goldenweed can also be abundant on roadsides, so road maintenance activities may threaten portions of some populations.

Photo 4. Pueblo goldenweed (*Oonopsis puebloensis*). Photo by Georgia Doyle.

Arkansas River feverfew (*Parthenium tetraneuris*); Sunflower Family (Asteraceae)

Arkansas River feverfew (Photo 5) is a narrow endemic species in the Cañon City - Fort Carson - Pueblo area, although there is a disjunct location of it in Salida (CNHP 2007). It is a low, early-flowering, cushion plant with stemless (or nearly so) white to pale cream disk flowers and a stout taproot. Arkansas River feverfew occurs primarily on Niobrara Formation although it has also been documented from various shale layers including Pierre and Graneros. There are approximately 30 extant occurrences of Arkansas River feverfew in Colorado (CNHP 2007). Although several occurrences have numbers of individuals that range in the tens to hundreds, like the occurrences at Fort Carson, it can occur in large populations numbering in the thousands where there is extensive undisturbed habitat. Primary threats to Arkansas River feverfew are limestone quarrying and encroaching urbanization (Colorado Native Plant Society 1997) as well as motorized recreation (Kelso et al. 1999).

There is ongoing taxonomic debate about the distinctness of this species. Treatment of the species in Flora of North America considers it a synonym of alpine feverfew, *Parthenium alpinum* (Flora of North America Editorial Committee 1993). However, the

basis for this treatment is a publication from 1950 by Rollins where he proposed treating *P. tetraneuris* as a variety of *P. alpinum*. This treatment was not widely accepted based on cytological differences between the species that likely preclude hybridization (*P. alpinum* is diploid and *P. tetraneuris* is tetraploid; Heidel and Handley 2004). Further, *P. alpinum* occurs in northeast Colorado, disjunct from locations of *P. tetraneuris*, and also grows on different substrates with different associated species (CNHP 2007). If *P. tetraneuris* is subsumed under *P. alpinum*, the global and state rank for the species would change to a G4/S3S4, and it would be moved from full tracking status to watch list status at CNHP.

Recommendations from Heidel and Handley (2004) for *Parthenium alpinum* suggest conducting molecular genetic research in tandem with cytological research to understand taxonomic relations between *P. alpinum* and *P. tetraneuris*. Denver Botanic Gardens staff is currently investigating possibilities for undertaking this research (Clark pers comm.).

The six occurrences of Arkansas River feverfew on Fort Carson occur on Penrose-Minnequa soils over Carlile shale and Niobrara Formation. Fort Carson contains 44 percent of the known occupied acres of Arkansas River feverfew, and 45 percent of the high quality occurrence acreage (Table 4).

Photo 5. Arkansas River feverfew (*Parthenium tetraneuris*). Photo by David Anderson.

Golden blazingstar (*Mentzelia chrysantha*); Blazingstar Family (Loasaceae)

Although not on the target species list for this project, golden blazingstar is tracked by CNHP (CNHP 2007) and listed as a Species of Special Concern at Fort Carson (Gene Stout and Associates 2007). Golden blazingstar (Photo 6) is a narrowly endemic species known only from the Cañon City-Fort Carson-Pueblo area in Colorado. It is currently known from 23 distinct locations, four of which are on Fort Carson, within its relatively small 530 square mile geographic range. Within this range it only occupies approximately 1,227 acres (Table 4) within an elevation range of 4,700-6,500 feet (Anderson 2006). Golden blazingstar is a biennial or short-lived perennial (Anderson 2006). It requires a minimum of two years to complete its life cycle; upon germination it grows into a basal rosette in the first year before bolting into a single stout stalk with a many-flowered, branched inflorescence no sooner than its second year. After flowering, individuals die. However, it can apparently persist as a rosette for several years, bolting when favorable climatic conditions occur. As expected for biennials, seed production can be prolific with a single capsule able to produce 50-80 seeds (Anderson 2006). There can be dozens of flowers per plant produced over its extended flowering and fruiting period, which is generally from July to September (Spackman et al. 1997). Seeds generally disperse in the immediate vicinity after being shaken out of its capsules and flung onto adjacent areas unless their sticky seeds attach to passing wildlife or other dispersal vector.

Golden blazingstar occupies shale barrens habitat, including Niobrara, Pierre, Carlile, Greenhorn, and Graneros shales, with Niobrara and Carlile comprising the most common substrate (CNHP 2007). Occurrences at Fort Carson occur primarily on Carlile shale near its interface with Niobrara Formation. Natural habitat for golden blazingstar is generally comprised of moderately disturbed, wasting shale slopes with unstable, fine-grained soils (Anderson 2006). These tend to be somewhat steep to very steep following the angle of repose, and thus are under a persistently moderate level of disturbance from gravity/mass wasting and wind deflation. Otherwise, the steep, unstable slopes are generally not regularly traversed. Due to the shale substrate, constant moderate disturbance on steep slopes or a combination of these and/or other factors, these slopes are naturally very sparsely vegetated. None of the known golden blazingstar occurrences are in completely natural habitat; all are affiliated with some sort of anthropogenic right-of-way (railroad, road, pipeline, powerline) that has cut through shale bedrock creating sparse vegetation in the disturbance. Several occurrences do have plants in pockets of natural habitat that are contiguous with various anthropogenic corridors such as railroads, road systems, and powerlines and pipelines. Golden blazingstar plants opportunistically colonize, and tend to occur in higher numbers, in anthropogenic habitat.

Primary threats to golden blazingstar include habitat conversion by residential or commercial development, mining, road right-of-way management, and exotic species invasion (Anderson 2006). Right-of-way maintenance has had documented impacts on golden blazingstar populations in Colorado. Best management practices for right-of-way occurrences of golden blazingstar were developed for and adopted by the Colorado Department of Transportation by Grunau et al. (2003). These practices may be relevant for Fort Carson.

The four occurrences of golden blazingstar at Fort Carson occur on Penrose-Minnequa soils adjacent to Razor clay or Manvel silt loam soils. All occur on shale bedrock (Carlile, Graneros, or Greenhorn). The 336 acres occupied by golden blazingstar on Fort Carson comprise 27 percent of the known rangewide acreage and 31 percent of the high quality occurrences (Table 4).

Photo 6. Golden blazing star (*Mentzelia chrysantha*). Photo by Georgia Doyle.

SUMMARY

Fort Carson contains many occurrences of the target species as well as other Species of Special Concern (Gene Stout and Associates 2007) and Species at Risk on military installations (Groves et al. 2000). Many of Fort Carson's occurrences are extensive and represent some of the highest quality locations known for the target species in the world. Thus the management of these species at Fort Carson will be important for the overall rangewide survival of these species (Grunau et al. 2007). The level of management responsibility and the potential for land use to impact for several of these rare species on Fort Carson is high.

Species for which Fort Carson has significant management responsibility and potential for impact include:

- **Round-leaf four-o'clock (*Mirabilis rotundifolia*)**: Fort Carson contains 45 percent of the known occupied acres and 49 percent of the acreage occupied by the high quality plant occurrence acreage
- **Arkansas River feverfew (*Parthenium tetraneuris*)**: Fort Carson contains 44 percent of the known occupied acres of Arkansas River feverfew, and 45 percent of the high quality plant occurrence acreage
- **Golden blazingstar (*Mentzelia chrysantha*)**: Fort Carson contains 27 percent of the known occupied acres and 31 percent of the high quality plant occurrence acreage

Species for which Fort Carson has a lower management responsibility and potential for impact include:

- Dwarf milkweed (*Asclepias uncialis* ssp. *uncialis*)
- Arkansas Valley evening primrose (*Oenothera harringtonii*)
- Pueblo goldenweed (*Oonopsis puebloensis*)

The rare plant mapping that resulted from these field surveys will facilitate natural resource planning at Fort Carson and has provided valuable data about these important elements of biodiversity. Continuing inventory efforts for these rare plant species is warranted. The life history of the target species and other important plant species not targeted in this report make it difficult to evaluate the potential extent that they are occurring on Fort Carson. The strong response to seasonal moisture causes variable expression of these plants from year to year. Further, the biennial and short-lived perennial habit of several species, such as Arkansas Valley evening primrose and golden blazingstar, make these species more transient in the landscape; they are known to persist within the vicinity of current known locations for years, but numbers and specific locations of individuals change over time. Initiating and continuing inventory for additional species (both plants and animals) and natural communities will further facilitate natural resource planning. Continuing monitoring efforts for the target species, additional Species of Special Concern on Fort Carson, and Species at Risk will inform trends of known occurrences on this military installation.

LITERATURE CITED

Anderson, D.G. 2006. *Mentzelia chrysantha* Engelmann ex Brandegee (golden blazingstar): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available at http://www.fs.fed.us/r2/projects/scp/assessments/ mentzeliachrysantha.pdf [July 17, 2006].

Bailey, R.G. 2001. Descriptions of the ecoregions of the United States. 2d ed. Misc. Publ. No. 1391 (rev.), Washington, D.C.: USDA Forest Service. 108 p. with 1:7,500,000-scale map.

Chapman, S.S., Griffith, G.E., Omernik, J.M., Price, A.B., Freeouf, J., and Schrupp, D.L., 2006, Ecoregions of Colorado (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,200,000).

Clark, Dina. 2007. Curator, Katherine Kalmbach Herbarium, Denver Botanic Gardens. Personal communication.

Colorado Geological Survey. 2003. Messages in stone: Colorado's colorful geology. Colorado Department of Natural Resources. Denver, CO.

Colorado Native Plant Society. 1997. Rare Plants of Colorado, Second Edition. Falcon Press, Helena, Montana.

Colorado Natural Heritage Program (CNHP). 2007. Biodiversity Tracking and Conservation System (BIOTICS). Colorado Natural Heritage Program, Colorado State University, Fort Collins, CO.

CU Museum (University of Colorado Museum of Natural History). 2006. Specimen Database of Colorado Vascular Plants. Accessible at http://cumuseum.colorado.edu/ Research/Botany/Databases/search.php.

Decker, K. 2006. *Asclepias uncialis* Greene (wheel milkweed): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/asclepiasuncialis.pdf [July 17, 2006].

Doesken, N.J., R.A.Pielke, and O. Bliss. 2003. Climate of Colorado. Climatography of the United States No. 60. Available at: http://ccc.atmos.colostate.edu/ climateofcolorado.php.

eFloras.org. 2007. Flora of North America [Online]. Accessible at http://efloras.org/. [September 1, 2007]

Flora of North America Editorial Committee, eds. 1993+. Flora of North America North of Mexico. 12+ vols. New York and Oxford.

Gene Stout and Associates. 2007. Integrated Natural Resources Management Plan 2007 - 2011: Fort Carson and Piñon Canyon Maneuver Site. Gene Stout and Associates, Loveland, CO.

Groves, C.R., L.S. Kutner, D.M. Stoms, M.P. Murray, J.M. Scott, M. Schafale, A.S. Weakley, and R.L. Pressey. 2000. Owning Up to Our Responsibilities: Who Owns Lands Important for Biodiversity? Pages 275-300. In Stein, B.A., L.S. Kutner, and J.S. Adams Eds. Precious Heritage: The Status of Biodiversity in the United States. Oxford University Press, New York.

Grunau, L., K. Decker, M. Fink, and C. Gaughan. 2007. Relationships among Species at Risk, Military Training, and Potential Federal Listing on Fort Carson and the Piñon Canyon Maneuver Site. Colorado Natural Heritage Program. Ft. Collins, CO.

Grunau, L., A.K. Ruggles, M. Venner, C. Pague, R. Rondeau, and J.M. Powell. 2003. Programmatic Biological Assessment, Conference Report, and Conservation Strategy for Impacts from Transportation Improvement Projects on Select Sensitive Species on Colorado's Central Shortgrass Prairie. Unpublished report prepared for the U.S. Fish and Wildlife Service.

Handwerk, J. 2007. Botany Information Manager/Co-Botany Team Leader, Colorado Natural Heritage Program. Personal communication.

Heckman, K. 1997. The ecology and distribution of *Oxybaphus rotundifolius*. Senior Thesis, Colorado College.

Heidel, B. and J. Handley. 2004. Parthenium alpinum (Nutt.) Torr. & Gray (alpine feverfew): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/ assessments/partheniumalpinum.pdf [July 17, 2006].

Kelso, S., G.W. Maentz, and C. Hall. 1999. A comparative study of the shale barrens flora on the Niobrara Formation in southeastern Colorado: flora, phytogeography, and response to disturbance. Report to the Colorado Natural Areas Program. Colorado College, Colorado Springs, CO.

Kelso, S., N. Bower, K. Heckmann, P.M. Beardsley, and D. Greve. 2003. Geobotany of the Niobrara Chalk Barrens in Colorado: A Study of Edaphic Endemism and Rarity. Department of Biology, Colorado College, Colorado Springs, CO. Western Great Basin Naturalist 63(3):299-313.

Ladyman, J.A.R. 2005. *Oenothera harringtonii* Wagner, Stockhouse & Klein (Colorado Springs evening-primrose): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/ scp/ assessments/oenotheraharringtonii.pdf [July 17, 2006].

Larsen, R.J., T.J. Wiggins, D.L. Holden, M.B. McCulloch, and R.E. Preator. 1979. Soil survey of Pueblo area, Colorado: parts of Pueblo and Custer Counties. USDA Soil Conservation Service. Washington, D.C.

Locklear, J.H. 1996. The biology, ecology and conservation needs of *Asclepias uncialis* Greene in Colorado. A status report submitted to the Colorado Natural Areas Program and the Colorado Native Plant Society.

Morgan, M., J. Temple, D. Morgan. 2006. Geologic map of the Mount Pittsburg quadrangle, El Paso, Pueblo, and Fremont Counties, Colorado. Colorado Geological Survey Open file report 06-05. Colorado Geological Survey. Denver, CO.

NatureServe. 2006. NatureServe: Standards and Methods, Natural Heritage Methodology. Available: http://www.natureserve.org/prodServices/heritagemethodology.jsp [October 1, 2006].

National Oceanic and Atmospheric Administration (NOAA). 2007. 2006 Annual Climate Review - U.S. Summary. National Climatic Data Center. Asheville, NC. Available: http://www.ncdc.noaa.gov/oa/climate/research/2006/ann/us-summary.html.

Neid, S., K. Decker, J. Handwerk, and S. Spackman Panjabi. 2007. Rare Plant Surveys on the Pinon Canyon Maneuver Site 2006-2007. Colorado Natural Heritage Program. Ft. Collins, CO.

Scott, G.R. 1964. Geology of the Northwest and Northeast Pueblo quadrangles, Colorado. U.S. Geological Survey. Washington, D.C.

Scott, G.R. 1969. Geologic map of the Southwest and Southeast Pueblo quadrangles, Colorado. U.S. Geological Survey. Washington, D.C.

Scott, G.R. 1972. Reconnaissance geologic map of the Swallows quadrangle, Pueblo County, Colorado. U.S. Geological Survey. Reston, VA.

Scott, G.R. and W.A. Cobban. 1964. Stratigraphy of the Niobrara Formation at Pueblo, Colorado. Geological Survey Professional Paper 454-L. U.S. Government Printing Office. Washington, D.C.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program. Available: http://www.cnhp.colostate.edu/ rareplants/ intro.html.

Spackman Panjabi, S. 2004. Visiting insect diversity and visitiation rates for seven globally imperiled plant species in Colorado's middle Arkansas Valley. Colorado Natural Heritage Program. Ft. Collins, Colorado. Available: http://www.cnhp.colostate.edu/documents/2004/Arkansas_pollinators.pdf.

The Nature Conservancy. 2001. Arkansas Valley Barrens Site Conservation Plan. Colorado Chapter of The Nature Conservancy. Boulder, Colorado.

Tweto, O. 1979. Geologic Map of Colorado: U.S.Geologic Survey, Special Geologic Map.

USDA, NRCS. 2007. The PLANTS Database (http://plants.usda.gov, 17 September 2006). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

USGS GAP Analysis Program. 2004. 1:500,000 Scale Geology for the Southwestern U.S. Unpublished material.

Weber, W.A. and R.C. Wittmann. 2001. Colorado Flora: Eastern Slope, Third Edition. University Press of Colorado, Boulder, Colorado.

Western Regional Climate Center. 2007. Period of record - monthly climate summary. [website.] Accessible: http://www.wrcc.dri.edu/. [October 1, 2007].

Appendix A. The Natural Heritage Network and Biological Diversity

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Appendix A. The Natural Heritage Network and Biological Diversity

Colorado is well known for its rich diversity of geography, wildlife, plants, and plant communities. However, like many other states, it is experiencing a loss of much of its flora and fauna. This decline in biological diversity is a global trend resulting from human population growth, land development, and subsequent habitat loss. Globally, the loss in species diversity has become so rapid and severe that it has been compared to the great natural catastrophes at the end of the Paleozoic and Mesozoic eras (Wilson 1988). The need to address this loss in biological diversity has been recognized for decades in the scientific community. However, many conservation efforts made in this country have not been based upon preserving biological diversity; instead, they have primarily focused on preserving game animals, striking scenery, and locally favorite open spaces. To address the absence of a methodical, science-based approach to preserving biological diversity, Robert Jenkins, a biologist working with The Nature Conservancy, developed the Natural Heritage Methodology in 1978 (The Nature Conservancy 2000).

Recognizing that rare and imperiled species are more likely to become extinct than common ones, the Natural Heritage Methodology ranks species according to their rarity or degree of imperilment. The ranking system is based upon the number of known locations of the species as well as its biology and known threats. By ranking the relative rarity or imperilment of a species, the quality of its populations, and the importance of associated conservation sites, the methodology can facilitate the prioritization of conservation efforts so the most rare and imperiled species may be preserved first. As the scientific community began to realize that plant communities are equally important as individual species, this methodology has also been applied to ranking and preserving rare plant communities as well as the best examples of common communities.

The Natural Heritage Methodology is used by Natural Heritage Programs throughout North, Central, and South America, forming an international database network. Natural Heritage Network data centers are located in each of the 50 U.S. states, five provinces of Canada, and 13 countries in South and Central America and the Caribbean. This network enables scientists to monitor the status of species from a state, national, and global perspective. It also enables conservationists and natural resource managers to make informed, objective decisions in prioritizing and focusing conservation efforts. For more information on the work of the Natural Heritage Network see www.natureserve.org.

What is Biological Diversity?

Protecting biological diversity has become an important management issue for many natural resource professionals. Biological diversity at its most basic level includes the full range of species on earth, from unicellular bacteria and protists through multi-cellular plants, animals, and fungi. At finer levels of organization, biological diversity includes the genetic variation within species, both among geographically separated populations and among individuals within a single population. On a wider scale, diversity includes variations in the biological communities in which species live, the ecosystems in which

communities exist, and the interactions among these levels. All levels are necessary for the continued survival of species and natural communities, and all are important for the well being of humans. It stands to reason that biological diversity should be of concern to all people.

The biological diversity of an area can be described at four levels:

1. **Genetic Diversity** -- the genetic variation within a population and among populations of a plant or animal species. The genetic makeup of a species is variable between populations within its geographic range. Loss of a population results in a loss of genetic diversity for that species and a reduction of total biological diversity for the region. Once lost, this unique genetic information cannot be reclaimed.

2. **Species Diversity** -- the total number and abundance of plant and animal species and subspecies in an area.

3. **Community Diversity** -- the variety of ecological communities within an area that represent the range of species relationships and interdependence. These communities may be characteristic of, or even endemic to, an area. It is within ecological communities that all life dwells.

4. **Landscape Diversity** -- the type, condition, pattern, and connectedness of ecological communities. A landscape consisting of a mosaic of ecological communities may contain one multifaceted ecosystem, such as a wetland ecosystem. A landscape also may contain several distinct ecosystems, such as a riparian corridor meandering through shortgrass prairie. Fragmentation of landscapes, loss of connections and migratory corridors, and loss of natural communities all result in a loss of biological diversity for a region. Humans and the results of their activities are integral parts of most landscapes.

The conservation of biological diversity must include all levels of diversity: genetic, species, community, and landscape. Each level is dependent on the other levels and inextricably linked. Often overlooked is the reality that humans are also linked to all levels of this hierarchy of diversity. The Colorado Natural Heritage Program believes that a healthy natural environment and human environment go hand in hand, and that recognition of the most imperiled species or communities is an important step in comprehensive conservation planning.

Colorado's Natural Heritage Program

CNHP is the state's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. After operating in Colorado for fourteen years, the Program was relocated from the State Division of Parks and Outdoor Recreation to the University of Colorado Museum in 1992 and then in 1994 to the College of Natural Resources at Colorado State University.

CNHP's multi-disciplinary team of scientists and information managers gathers comprehensive information on rare, threatened, and endangered species and significant ecological communities of Colorado. Life history, status, and locational data are incorporated into a continually updated data system. Sources include published and unpublished literature, museum and herbaria labels, and field surveys conducted by knowledgeable naturalists, experts, agency personnel, and our own staff of botanists, ecologists, and zoologists. Information management staff oversee the transcription and mapping of the data and physical locations into the BIOTICS data system. BIOTICS combines an Oracle relational database with a geographic information system (Arc/GIS). The data in the database can be accessed through a variety of attributes, including taxonomic group, global and state rarity rank, federal and state legal status, source, observation date, county, quadrangle map, watershed, management area, township, range, and section, precision, and conservation unit.

CNHP is part of an international network of conservation data centers that uses BIOTICS for its data management. CNHP has effective relationships with several state and federal agencies, including the Colorado Natural Areas Program, Colorado Department of Natural Resources and the Colorado Division of Wildlife, the U.S. Environmental Protection Agency, the U.S. Bureau of Land Management and the U.S. Forest Service. Numerous local governments and private entities also work closely with CNHP. Use of the data by many different individuals and organizations, including Great Outdoors Colorado, encourages a proactive approach to development and conservation thereby reducing the potential for conflict. Information collected by the Natural Heritage Programs around the globe provides a means to protect species before the need for legal endangerment status arises.

Concentrating on site-specific data for each species or community enables the evaluation of the significance of each location with respect to the conservation of natural biological diversity in Colorado and the nation. By using species imperilment ranks and quality ratings for each location, priorities can be established for the protection of the most sensitive or imperiled sites. CNHP's BIOTICS is a GIS based priority-setting system that provides land managers with an effective, proactive land-planning tool. For more information on the work of the Colorado Natural Heritage Program please see www.cnhp.colostate.edu.

The Natural Heritage Ranking System

Each of the plant or animal species and ecological communities tracked by CNHP is considered an **element of natural diversity**, or simply an **element**. Each element is assigned a rank that indicates its relative degree of imperilment on a five-point scale (e.g., 1 = extremely rare/imperiled, 5 = abundant/secure). The primary criterion for ranking elements is the number of occurrences, i.e., the number of known distinct localities or populations. The number of occurrences is weighted more heavily than other criteria because an element found in one place is more imperiled than something found in twenty-one places. Also considered in defining the element imperilment rank is the size

of the geographic range, the number of individuals, trends in population and distribution, identifiable threats, and the number of already protected occurrences.

Element imperilment ranks are assigned both in terms of the element's degree of imperilment within Colorado (its State or S-rank) and the element's imperilment over its entire range (its Global or G-rank). Taken together, these two ranks indicate the degree of imperilment of an element. For example, the lynx, which is thought to be secure in northern North America but is known from less than 5 current locations in Colorado, is ranked G5S1. Naturita milkvetch, which is known from 37 locations in the Four Corners Area, is ranked a G3S3, vulnerable both globally and in Colorado. Further, a tiger beetle that is only known from one location in the world at the Great Sand Dunes National Monument is ranked G1S1, critically imperiled both globally and in Colorado. CNHP actively collects, maps, and electronically processes specific occurrence information for elements considered extremely imperiled to vulnerable (S1 - S3). Those with a ranking of S3S4 are "watchlisted," meaning that specific occurrence data are collected and periodically analyzed to determine whether more active tracking is warranted. A complete description of each of the Natural Heritage ranks is provided in Table 1.

This single rank system works readily for all species except those that are migratory. Those animals that migrate may spend only a portion of their life cycles within the state. In these cases, it is necessary to distinguish between breeding, non-breeding, and resident species. As noted in Table 1, ranks followed by a "B", e.g., S1B, indicate that the rank applies only to the status of breeding occurrences. Similarly, ranks followed by an "N", e.g., S4N, refer to non-breeding status, typically during migration and winter. Elements without this notation are believed to be year-round residents within the state.

Legal Designations

Natural Heritage imperilment ranks are not legal designations and should not be interpreted as such. Although most species protected under state or federal endangered species laws are extremely rare, not all rare species receive legal protection. Legal status is designated by either the U.S. Fish and Wildlife Service under the Endangered Species Act or by the Colorado Division of Wildlife under Colorado Statutes 33-2-105 Article 2. State designations apply to animals only; Colorado has no legal list of threatened and endangered plant species (Buckner and Bunin 1992).

In addition, the U.S. Forest Service and Bureau of Land Management recognize some species as “Sensitive”. Table 2 defines the special status assigned by these agencies and provides a key to the abbreviations used by CNHP.

Please note that the U.S. Fish and Wildlife Service has issued a Notice of Review in the February 28, 1996 Federal Register for plants and animal species that are "candidates" for listing as endangered or threatened under the Endangered Species Act. The revised candidate list replaces an old system that listed many more species under three categories: Category 1 (C1), Category 2 (C2), and Category 3 (including 3A, 3B, 3C). Beginning with the February 28, 1996 notice, the Service will recognize as candidates for

listing most species that would have been included in the former Category 1. This includes those species for which the Service has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act. Candidate species listed in the February 28, 1996 Federal Register are indicated in Table 2 with a "C".

Table 1. Definition of CNHP Imperilment Ranks.

Global imperilment ranks are based on the range-wide status of a species. State imperilment ranks are based on the status of a species in an individual state. State and Global ranks are denoted, respectively, with an "S" or a "G" followed by a character. **These ranks should not be interpreted as legal designations.**

G/S1	Critically imperiled globally/state because of rarity (5 or fewer occurrences in the world/state; or very few remaining individuals), or because some factor of its biology makes it especially vulnerable to extinction.
G/S2	Imperiled globally/state because of rarity (6 to 20 occurrences), or because of other factors demonstrably making it very vulnerable to extinction throughout its range.
G/S3	Vulnerable throughout its range or found locally in a restricted range (21 to 100 occurrences).
G/S4	Apparently secure globally/state, though it might be quite rare in parts of its range, especially at the periphery.
G/S5	Demonstrably secure globally, though it may be quite rare in parts of its range, especially at the periphery.
GX	Presumed extinct.
G#?	Indicates uncertainty about an assigned global rank.
G/SU	Unable to assign rank due to lack of available information.
GQ	Indicates uncertainty about taxonomic status.
G/SH	Historically known, but not verified for an extended period.
G#T#	Trinomial rank (T) is used for subspecies or varieties. These species or subspecies are ranked on the same criteria as G1-G5.
S#B	Refers to the breeding season imperilment of elements that are not permanent residents.
S#N	Refers to the non-breeding season imperilment of elements that are not permanent residents. Where no consistent location can be discerned for migrants or non-breeding populations, a rank of SZN is used
SZ	Migrant whose occurrences are too irregular, transitory, and/or dispersed to be reliably identified, mapped, and protected.
SA	Accidental in the state.
SR	Reported to occur in the state, but unverified.
S?	Unranked. Some evidence that species may be imperiled, but awaiting formal rarity ranking.

Notes: Where two numbers appear in a state or global rank (e.g., S2S3), the actual rank of the element falls between the two numbers.

Element Occurrence Ranking

Actual locations of elements, whether they are single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. In order to prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the estimated viability or probability of persistence (whenever sufficient information is available). This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful. The EO-Rank is based on 3 factors:

Size – a quantitative measure of the area and/or abundance of an occurrence such as area of occupancy, population abundance, population density, or population fluctuation.

Condition – an integrated measure of the quality of biotic and abiotic factors, structures, and processes within the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include reproduction and health, development/maturity for communities, ecological processes, species composition and structure, and abiotic physical or chemical factors.

Landscape Context – an integrated measure of the quality of biotic and abiotic factors, and processes surrounding the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include landscape structure and extent, genetic connectivity, and condition of the surrounding landscape.

Table 2. Federal and State Agency Special Designations.

Federal Status:

1. U.S. Fish and Wildlife Service (58 Federal Register 51147, 1993) and (61 Federal Register 7598, 1996)

LE Endangered; species or subspecies formally listed as endangered.

E(S/A) Endangered due to similarity of appearance with listed species.

LT Threatened; species or subspecies formally listed as threatened.

P Potential Endangered or Threatened; species or subspecies formally listed as potentially endangered or threatened.

PD Potential for delisting

C Candidate: species or subspecies for which the U.S. Fish and Wildlife Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.

2. U.S. Forest Service (Forest Service Manual 2670.5) (noted by the Forest Service as "S")

FS Sensitive: those plant and animal species identified by the Regional Forester for which population viability is a concern as evidenced by:
a. Significant current or predicted downward trends in population numbers or density.
b. Significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution.

3. Bureau of Land Management (BLM Manual 6840.06D) (noted by BLM as "S")

BLM Sensitive: those species found on public lands, designated by a State Director that could easily become endangered or extinct in a state. The protection provided for sensitive species is the same as that provided for C (candidate) species. This list does not include species that are listed endangered (LE) or threatened (LT).

State Status:

1. Colorado Division of Wildlife

CO-E Endangered

CO-T Threatened

CO-SC Special Concern

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then averaged to determine an appropriate EO-Rank for the occurrence. If there is insufficient information available to rank an element occurrence, an EO-Rank is not assigned. Possible EO-Ranks and their appropriate definitions are as follows:

A Excellent estimated viability.
B Good estimated viability.
C Fair estimated viability.
D Poor estimated viability.
E Viability has not been assessed.
H Historically known, but not verified for an extended period of time
X Extirpated

Potential Conservation Areas

In order to successfully protect populations or occurrences, it is necessary to delineate areas needed for their conservation. These "Potential Conservation Areas" (PCA) focus on capturing the ecological processes that are necessary to support the viable persistence of an element occurrence. A PCA may include a single occurrence of an element or a suite of element occurrences. Not all element occurrences are included in PCA's. PCA's are ordinarily drawn for A to C ranked G1 to G3 and S1 or S2 elements only. Other lower ranked element occurrences may fall geographically within the site boundaries, and are thus included, but would not warrant a PCA on their own.

The goal of the process is to identify a land area that can provide the habitat and ecological processes upon which a particular element occurrence or suite of element occurrences depends for its continued existence. The best available knowledge of each species' life history is used in conjunction with information about topographic, geomorphic, and hydrologic features, vegetative cover, as well as current and potential land uses. CNHP PCA's are referred to by the BLM as "Areas of Biological Significance".

In developing PCA boundaries, CNHP biologists consider a number of factors that include, but are not limited to:

- the extent of current and potential habitat for the elements present, considering the ecological processes necessary to maintain or improve existing conditions;
- species movement and migration corridors;
- maintenance of surface water quality within the site and the surrounding watershed;
- maintenance of the hydrologic integrity of the groundwater, e.g., by protecting recharge zones;
- land intended to buffer the site against future changes in the use of surrounding lands;

- exclusion or control of invasive exotic species;
- land necessary for management or monitoring activities.

The proposed boundary does not recommend the exclusion of all activity. It is hypothesized that some activities will prove degrading to the element or the process on which the element depends, while others will not. Specific activities or land use changes proposed within or adjacent to the PCA boundary should be carefully considered and evaluated for their implications to the survival of the elements for which the PCA is primarily defined and the other elements that also fall within the site.
The PCA boundaries presented here are for planning and management purposes. They delineate ecological areas where land-use practices should be carefully planned and managed to ensure compatibility with protection goals for natural heritage elements. Please note that PCA boundaries are based primarily on our understanding of the ecological systems. A thorough analysis of the human context and potential stresses was not conducted. All land within the conservation planning boundary should be considered an integral part of a complex economic, social, and ecological landscape that requires thoughtful land-use planning at all levels.

Off-Site Considerations

It is often the case that all relevant ecological processes cannot be contained within a PCA of reasonable size. For instance, while a PCA for Colorado River cutthroat trout may be drawn to include only a portion of the riparian zone of a river or creek, it should be noted that the ecological functions that determine the viability of the occurrence operate at the watershed scale. Activities throughout the entire watershed can affect water quality and hydrology of the river, which in turn may affect the trout's local habitat and population viability. The boundaries illustrated in this report signify the immediate, and therefore most important, area in need of protection. Continued landscape level planning and conservation efforts are needed. This requires coordination and cooperation with private landowners, neighboring land planners, and state and federal agencies with jurisdictions and interests across the landscape.

Ranking of Potential Conservation Areas

Biological Diversity Rank

CNHP uses element and element occurrence ranks to assess the biological diversity significance of a site. If an element occurrence is unranked due to a lack of information, the element occurrence rank is considered a C rank. Similarly, if an element is a "GU" or "G?" it is treated as a "G4". Based on these ranks, each site is assigned a **Biological Diversity rank (B rank)**:

B1 Outstanding Significance: the only site known for an element or an excellent occurrence of a G1 species.

B2 Very High Significance: one of the best examples of a community type, good occurrence of a G1 species, or excellent occurrence of a G2 or G3 species.

B3 High Significance: excellent example of any community type, good occurrence of a G3 species, or a large concentration of good occurrences of state rare species.

B4 Moderate or Regional Significance: good example of a community type, excellent or good occurrence of state-rare species.

B5 General or Statewide Biological diversity Significance: good or marginal occurrence of a community type, S1, or S2 species.

Protection Urgency Ranks

Protection urgency ranks (P-ranks) refer to the time frame in which conservation protection should occur in order to prevent the loss of the element. In most cases, this rank refers to the need for a major change of protective status (e.g., agency special area designations or ownership). The urgency for protection rating reflects the need to take legal, political, or other administrative measures to alleviate potential threats that are related to land ownership or designation. The following codes are used to indicate the urgency to protect the area:

P1 May be immediately threatened by severely destructive forces, within 1 year of rank date,
P2 Threat expected within 5 years,
P3 Definable threat but not in the next 5 years,
P4 No threat known for foreseeable future,
P5 Land protection complete, or adequate reasons exists not to protect the site.

A protection action involves increasing the current level of legal protection accorded one or more tracts of a potential conservation area. Protection strategies on public lands may include special designations such as Wilderness, Research Natural Areas (RNA), or Areas of Critical Environmental Concern (ACEC). They may also include activities such as educational or public relations campaigns or collaborative planning efforts with public or private entities to minimize adverse impacts to element occurrences at a site. Protection in this sense does not include management actions.

Management Urgency Ranks

Management urgency ranks (M-ranks) indicate the time frame in which a change in management of the element or site must occur in order to ensure the element's future existence. Using best scientific estimates, this rank refers to the need for management in contrast to protection (e.g., increased fire frequency, decreased grazing, weed control, etc.). The urgency for management rating focuses on land use management or land stewardship action required to maintain element occurrences in the PCA.

A management action may include biological management (prescribed burning, removal of exotics, mowing, etc.) or people and site management (building barriers, rerouting trails, patrolling for collectors, hunters, or trespassers, etc.). It may also include conducting further research or monitoring. Management action does not include legal,

political, or administrative measures taken to protect a potential conservation area. The following codes are used to indicate the action needed at the area:

- **M1** Management action may be required immediately or element occurrences could be lost or irretrievably degraded within one year,
- **M2** New management action may be needed within 5 years to prevent the loss of element occurrences,
- **M3** New management action may be needed within 5 years to maintain current quality of element occurrences,
- **M4** Although the element is not currently threatened, management may be needed in the future to maintain the current quality of element occurrences,
- **M5** No serious management needs known or anticipated at the site.

References

Buckner, D. L. and J. E. Bunin. 1992. Final Report 1990/91 Status Report for Penstemon harringtonii. Unpublished report prepared for Colorado Natural Areas Program, Denver, CO by Esco Assoc., Inc., Boulder, CO.

The Nature Conservancy and The Association for Biological Diversity. 2000. Precious Heritage: The Status of Biodiversity in the United States. Eds: Bruce A. Stien, Lynn S. Kutner, and Jonathan S. Adams. Oxford University Press. 399 pp.

Wilson, E. O. 1988. Biodiversity. National Academy Press, Washington D.C. 520 pp.

Appendix B. Potential Conservation Areas

Fort Carson is within an extensive Potential Conservation Area, Rare Plants of the Chalk Barrens.

Rare Plants of the Chalk Barrens

Biodiversity Rank - B1: Outstanding Biodiversity Significance

Protection Urgency Rank - P2: Threat/Opportunity within 5 Years

Management Urgency Rank - M4: Not Needed Now; No Current Threats; May Need in Future

U.S.G.S. 7.5-minute quadrangles: Florence, Florence SE, Hobson, Northwest Pueblo, Pierce Gulch, Steele Hollow, Stone City, Swallows

Size: 87,780 acres (35,523 ha) **Elevation:** 4,800 - 5,600 ft. (1,463 - 1,707 m)

General Description: The site is characterized by barrens and breaks of Late Cretaceous shales, limestones, and chalks that formed in the ancient alluvial terraces of the Arkansas River and its tributaries. The modern river course has cut a deep canyon through the sedimentary bedrock that drops off in steep slopes adjacent to the river. Late Cretaceous sedimentary layers are a composite of Carlile shale, Greenhorn limestone, and Graneros shale as well as extensive swaths of Niobrara Formation. The barrens habitat that hosts the rare plants typically has low vegetative cover (10-20%). The surface of the shale barrens generally consists of small, platy rock fragments over a shallow, fine-textured soil matrix. Soils are calcareous and moderately to strongly alkaline. The shale breaks support a mosaic of plant communities with the unifying feature of a sparse herbaceous layer characterized by low cushion plants like woollycup buckwheat (*Eriogonum lachnogynum*), nailworts (*Paryonychia jamesii, P. sessilifolia*), stemless four-nerve daisy (*Tetraneuris acaulis*), bladderpods (*Lesquerella* spp.), and Arkansas River fever few (*Parthenium tetraneuris*). The breaks vegetation mosaic includes pinon - juniper woodlands (*Pinus edulis* and *Juniperus monosperma*) and shrublands with Bigelow sagebrush (*Artemisia bigelovii*) and/or James' frankenia (*Frankenia jamesii*) as well as herbaceous-dominated patches. The landscape surrounding the barrens is a mix of pinon - juniper savanna interspersed with grasslands. The site contains extensive old growth stands of juniper and pinon - juniper savannas with New Mexico feathergrass (*Hesperostipa neomexicana*), side oats grama (*Bouteloua curtipendula*), and ring muhly (*Muhlenbergia torreyi*). Grasslands are dominated by galleta grass (*Pleuraphis jamesii*) and blue grama (*Bouteloua gracilis*). Scattered shrubs include cholla cactus (*Cylindropuntia imbricata*), fourwing saltbush (*Atriplex canescens*), and winterfat (*Krascheninnikovia lanata*). The portions of the site north of Highway 50 are generally less dissected by development and roads than the portions along the Arkansas River. North of Highway 50, especially in the Beaver Creek area, taller grasses, including New Mexico feathergrass, occur. The Arkansas River runs through the site, and supports riparian vegetation dominated by cottonwood (*Populus deltoides*) degraded with invasive non-native plants including tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*).

Key Environmental Factors: Outcrops and barrens of Late Cretaceous sedimentary

bedrock embedded in a landscape mosaic of grasslands, dwarf shrublands, and pinon - juniper woodlands and savannas.

Biodiversity Significance Rank Comments (B1): This site is a botanical hotspot and contains excellent (A-ranked) and good (B-ranked) occurrences of six globally imperiled (G2/S2) plant species: round-leaf four-o'clock (*Oxybaphus rotundifolius*), golden blazing star (*Nuttallia chrysantha*), Pueblo goldenweed (*Oonopsis puebloensis*), Rocky Mountain bladderpod (*Lesquerella calcicola*), Arkansas Valley evening primrose (*Oenothera harringtonii*) and Fendler's townsend-daisy (*Townsendia fendleri*). The site also contains excellent (A-ranked) occurrences of the globally vulnerable (G3/S3) Barneby's fever-few (*Bolophyta tetraneuris*), good (B-ranked) occurrences of dwarf milkweed (*Asclepias uncialis* spp. *uncialis*) and excellent (A-ranked) occurrences of frankenia / Indian ricegrass (*Frankenia jamesii / Achnatherum hymenoides*) communities (GU) and the common one-seeded juniper / New Mexico feathergrass (*Juniperus monosperma / Hesperostipa neomexicana*) woodlands. High concentrations of rare plants merit an outstanding biodiversity significance rank.

Natural Heritage element occurrences at the Rare Plants of the Chalk Barrens PCA.

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Hesperostipa comata Colorado Front Range Herbaceous Vegetation	Great Plains Mixed Grass Prairie	G1G2	S1S2				C	1983-07-13
Natural Communities	Hesperostipa neomexicana Herbaceous Vegetation	Great Plains Mixed Grass Prairie	G3	S3				B	1983-07-13
Natural Communities	Hesperostipa neomexicana Herbaceous Vegetation	Great Plains Mixed Grass Prairie	G3	S3				B	1983-07-14
Natural Communities	Hesperostipa neomexicana Herbaceous Vegetation	Great Plains Mixed Grass Prairie	G3	S3				BC	1983-07-14
Natural Communities	Hesperostipa neomexicana Herbaceous Vegetation	Great Plains Mixed Grass Prairie	G3	S3				CD	1988-05-09
Natural Communities	Artemisia bigelovii / Achnatherum hymenoides Shrubland	Plains Escarpment Prairies (Limestone Breaks)	G3Q	S3Q				B	1983-07-12
Natural Communities	Artemisia bigelovii / Achnatherum hymenoides Shrubland	Plains Escarpment Prairies (Limestone Breaks)	G3Q	S3Q				B	1983-07-13
Natural Communities	Artemisia bigelovii / Achnatherum hymenoides Shrubland	Plains Escarpment Prairies (Limestone Breaks)	G3Q	S3Q				BC	1983-07-13
Natural Communities	Artemisia bigelovii / Achnatherum hymenoides Shrubland	Plains Escarpment Prairies (Limestone Breaks)	G3Q	S3Q				BC	1983-07-19
Natural Communities	Juniperus monosperma / Hesperostipa neomexicana Woodland	Foothills Pinyon - Juniper Woodlands	G4	S3				C	1983-07-21

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Natural Communities	Frankenia jamesii / Achnatherum hymenoides Shrubland	Foothills Shrubland	GU	SU				B	1995-06-14
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2				B	2006-08-16
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2				B	2006-08-18
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2				B	2006-09-07
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2				B	2006-11-02
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2				C	2006-09-06
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2				E	1998-06-13
Vascular Plants	Lesquerella calcicola	Rocky Mountain bladderpod	G2	S2					
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	A	2006-08-18
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	AB	2006-08-29
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	B	1998-05-29
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	B	2001-08-23
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	B	2002-08-19
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	B	2007-07-10
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	BC	2007-05-21
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	C	1998-05-29
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	C	2000-11-11
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	C	2006-08-14
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	D	2007-08-19
Vascular Plants	Nuttallia chrysantha	golden blazing star	G2	S2			BLM	E	1993-07-09

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2000-11-11
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2005-07-06
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2006-07-18
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2006-08-16
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2006-08-18
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2007-07-11
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				A	2007-08-14
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				B	1995-06-08
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				B	1995-07-06
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				B	2001-07-01
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				B	2004-06-23
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				C	1995-06-07
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				C	1995-99-99
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				C	2006-10-22
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				C	2007-06-05
Vascular Plants	Oonopsis sp. 1	Pueblo goldenweed	G2	S2				C	
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				A	2003-06-05
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				A	2006-08-18
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				A	2007-05-09
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				A	2007-07-10
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	1995-07-06

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2003-06-05
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2004-06-22
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2006-08-18
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2007-05-04
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2007-06-01
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2007-06-05
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2007-07-09
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2007-07-11
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				B	2007-08-07
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	1990-06-17
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	1992-06-26
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	1995-06-19
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	1995-07-05
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	1998-05-29
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	2006-08-17
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				C	2007-08-15
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				D	1995-08-08
Vascular Plants	Oxybaphus rotundifolius	round - leaf four - o'clock	G2	S2				H	1901-06-01
Vascular Plants	Townsendia fendleri	Fendler's townsend - daisy	G2	S1				B	2006-09-07
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	A	2006-08-16

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	A	2007-07-18
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	AB	2006-07-19
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	B	2001-07-22
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	B	2007-06-01
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	B	2007-07-10
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	BC	2007-07-05
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	BC	
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	C	1995-06-12
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	C	2006-08-17
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	C	
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	D	2001-05-31
Vascular Plants	Oenothera harringtonii	Arkansas Valley evening primrose	G2G3	S2S3			USFS	H	1942-06-12
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				A	1995-07-05
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				A	1997-05-05
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				A	1998-06-04
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				AB	1990-05-16

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				AC	1995-06-15
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	1989-06-14
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	1990-05-99
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	1992-06-26
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	1998-05-29
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	1998-06-04
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	2002-06-06
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	2007-05-02
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	2007-09-12
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				B	
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				BC	2007-07-10
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				BC	2007-09-09
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				C	1993-06-21
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				C	1998-05-28
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				C	1998-05-29
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				C	1998-06-03
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				C	2007-06-01
Vascular Plants	Bolophyta tetraneuris	Barneby's fever - few	G3	S3				H	1983-07-13
Vascular Plants	Asclepias uncialis ssp. uncialis	dwarf milkweed	G3G4T2T3	S2			BLM/USFS	B	1995-05-06
Vascular Plants	Asclepias uncialis ssp. uncialis	dwarf milkweed	G3G4T2T3	S2			BLM/USFS	B	1995-06-09

Major Group	State Scientific Name	State Common Name	Global Rank	State Rank	Federal Status	State Status	Fed Sens	EO Rank	Last Obs Date
Vascular Plants	Asclepias uncialis ssp. uncialis	dwarf milkweed	G3G4T2 T3	S2			BLM/ USFS	C	2007-05-02
Vascular Plants	Asclepias uncialis ssp. uncialis	dwarf milkweed	G3G4T2 T3	S2			BLM/ USFS	C	

** The records above are sorted in the following order 1) Major Group 2) Global Rank and 3) Scientific name.

Boundary Justification: The boundary encompasses the concentration of element occurrences plus unsurveyed, apparently suitable habitat in the vicinity of the occurrences. Basinwide vegetation data (CDOW 2001) for the Arkansas River were used in conjunction with the element occurrence data to design the site boundary. Most of the element occurrences fall within the "Sparse Pinon Juniper/Shrub/Rock Mix" basinwide vegetation mapping unit. Kelso and others (2003) noted that the Middle Chalk and Upper Chalk units of the Smoky Hills Member of the Niobrara Formation are the most botanically important barrens of the area. Fine-scale geologic data delineating members of formations was not available when designing the site boundary. In general, site boundaries are drawn to represent our best estimate of the primary area needed for the survival of the occurrences. This area is sufficiently large to protect intact (or at least allow simulation of) most of the natural ecological processes necessary for survival of the species, including fire, herbivory, and hydrology. The boundaries also include the mosaic of local community types on which the species' may rely.

Protection Urgency Rank Comments (P2): About 70% of the site is privately owned and about 25% is part of the Fort Carson Military Reservation; the remainder is a mixture of State and BLM lands. Included within the boundary is the Pueblo State Wildlife Area and Lake Pueblo State Park managed by the Colorado Division of Wildlife and Colorado State Parks. Most of the privately owned portion has no protection status and residential development and limestone mining pressures are high. Further development of Pueblo West may encroach on the site. Holnam and Ideal Cement Company own part of the property and portions may have already undergone limestone mining and no longer be habitat for the rare plants. To ensure long-term protection for the rare plants at this site, work with the Fort Carson Military Reservation, Pueblo State Wildlife Area, Lake Pueblo State Park, Bureau of Reclamation and the private landowners.

General Protection Comments: State lands offer some protection, from residential development for example. However, developments on private lands and developments associated with the State Park infrastructure could threaten the occurrences in the future. Juniper Breaks Campground was constructed within the globally imperiled plant populations, and although the populations are probably still viable, individual plants were destroyed, and the habitat was fragmented at this

location. Imperiled plants were also lost during the construction of Pueblo Reservoir. Any expansion of the Reservoir would result in the loss of additional plants, and potentially the loss of populations. Special designation for the rare plants and their habitat could provide protection for these species in this important area. In the Rohr Gulch area, a private landowner indicated that he is currently involved in negotiations with Lafarge for starting strip mining. Mining of limestone for asphalt would begin within a few years. The mining would take about 30 feet of the surface material, Fort Hayes Limestone. The Nature Conservancy has developed a range-wide conservation plan for all of the narrowly restricted endemic plants of the Arkansas Valley Shale Barrens from Canon City to Pueblo (The Nature Conservancy 2001), which could serve as a useful reference. Without protection planning, habitat for these species could become so restricted and fragmented that viable populations cannot be sustained.

Management Urgency Rank Comments (M4): The shale barrens are minimally degraded and require little or no management. Threats include mining for cement products, residential expansion, and off-road vehicle use. Roadside areas and many areas of the grassland communities are degraded and in need of restoration. Further inventory and monitoring for rare plants and weeds would provide additional information to guide management decisions. Need to know future plans for the State Wildlife Area to prevent visitor use impacts such as trampling. Current management appears to be adequate, however, military maneuvers on Fort Carson may impact the plant populations at the north end of the site.

Management Needs Comments: The greatest threats to the species and communities at this site are likely related to recreational uses. Careful planning to streamline visitor use in the Pueblo Reservoir area away from rare plant habitat and high quality plant occurrences would help the elements of concern survive in this important area over time. Recreational uses of concern include but may not be limited to: off road vehicle use, hiking, fishing, camping. Several non-native and potentially problematic weed species were found to be abundant in places in the site, including cheatgrass (*Bromus tectorum*), mullein (*Verbascum thapsus*), and Russian thistle (*Salsola* sp.). Although these exotic species have not extensively spread to the shale barrens that support the imperiled plants, monitoring the spread of noxious weeds within the site would help identify problems that could increase over time. Further inventory and detailed mapping of the imperiled species would also assist with management decision-making. The primary current and historical land use on many areas within the site is cattle grazing, which does not appear to be presenting any management issues.

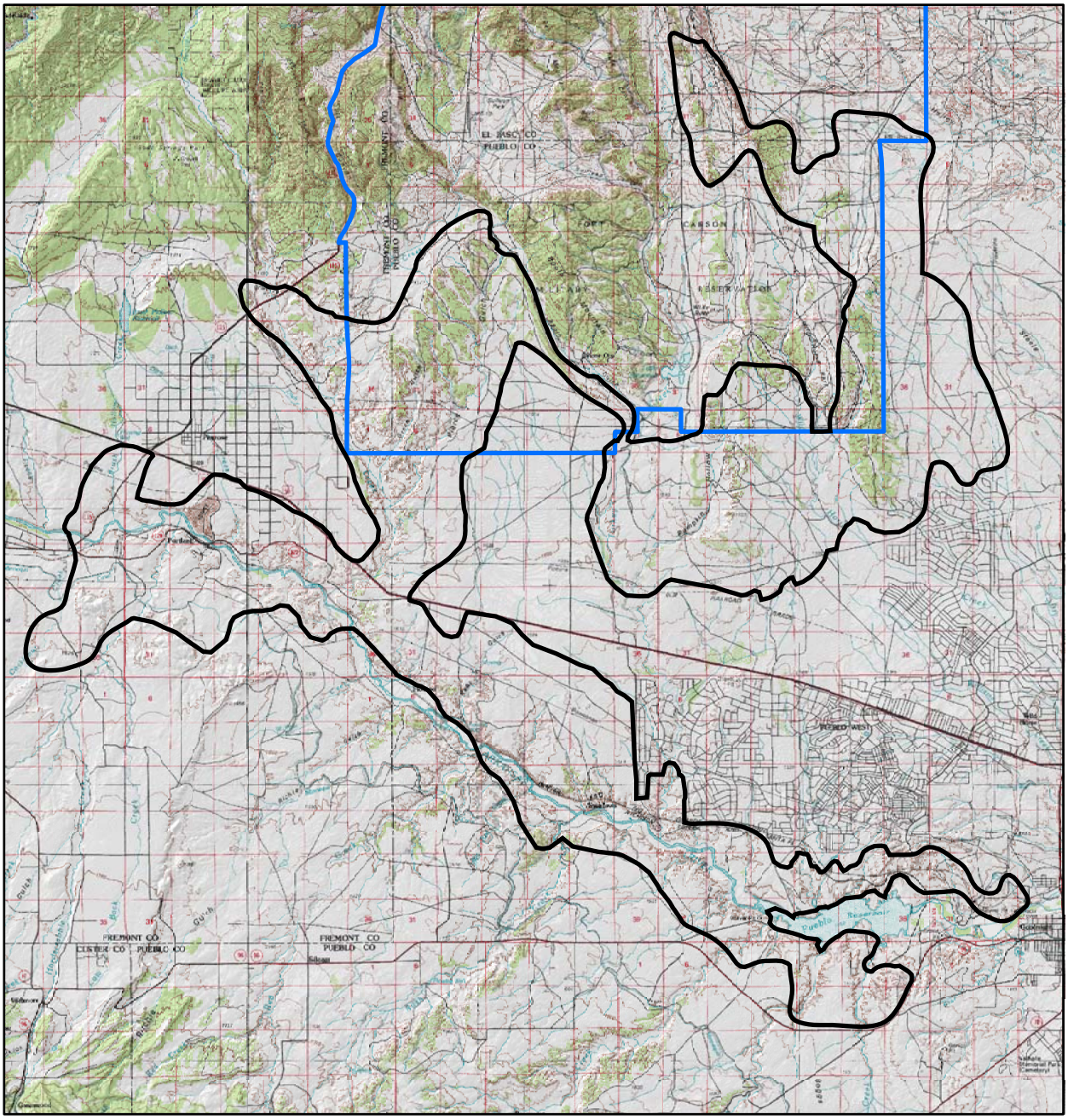
Land Use Comments: Portions of the site are currently grazed; portions undergo light recreational use; portions undergo military maneuvers.

Exotic Species Comments: Exotic plants, including *Bromus tectorum*, *Verbascum thapsus*, and *Salsola* sp., are abundant in some areas adjacent to the occurrences, especially along roadsides. Salsola tumbleweeds are also beginning to choke a

majority of the steep-sided gullies adjacent to rare plant occurrences. However, in general, exotic species have not spread to the shale barrens.

Off-Site Considerations: In close proximity to Pueblo, Pueblo West, and Pueblo Reservoir.

Information Needs: Need current land management and future plans for site, especially privately owned portions. Further inventory for these species is needed; some areas have not yet been accessible for survey.



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Colorado Natural Heritage Program
Colorado State University
254 General Services Building
8002 Campus Delivery
Fort Collins, CO 80523-8002

Ph (970) 491-1309
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Map Date: 12/14/2007

Legend

PCA Boundary

Fort Carson

Pueblo, 38104-A1
Canon City, 38105-A1
Colorado Springs, 38104-E1

30 x 60 Minute Digital Raster Graphics produced by the U.S. Geological Survey

Location in Fort Carson

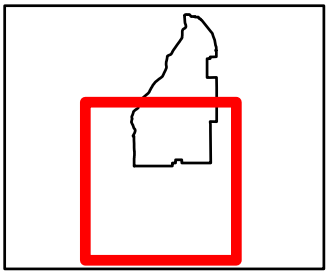

Figure 5. Rare Plants of the Chalk Barrens Potential Conservation Area, B1: Outstanding Biodiversity Significance

Appendix C. Species Characterization Abstracts

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State Name: *Asclepias uncialis* ssp. *uncialis* (dwarf milkweed)
Global Name: *Asclepias uncialis* ssp. *uncialis* (Greene's Milkweed)

Taxonomy
Class: Dicotyledoneae
Order: Gentianales
Family: Asclepiadaceae

Taxonomic Comments: *A. uncialis* ssp. *uncialis* in the Kartesz (1994) sense is the same entity as *A. uncialis* sensu stricto (excluding *A. uncialis* ssp. *ruthiae*).

Ranks and Status
Global Rank: G3G4T2T3
State Rank: S2
Federal Protection Status: BLM and USFS Sensitive Species
State Protection Status: None

Description and Phenology
Non-Technical Description: A small, herbaceous perennial with several to many stems 1 to 2.5 inches high. Stems have milky sap. Leaves are primarily opposite, and are of two different forms - lower leaves are oval to lanced shaped, while upper leaves are much narrower. Flowers have five reflexed petals with attendant hoods and horns. Flowers of *A. uncialis* ssp. *uncialis* are rose-purple, appearing in clusters at the tips of the stems, and are reported to have a strong fragrance (Zimmerman 1993).

Diagnostic Characteristics: Small stature, early blooming period, and heterophyllous leaves are diagnostic field characteristics.

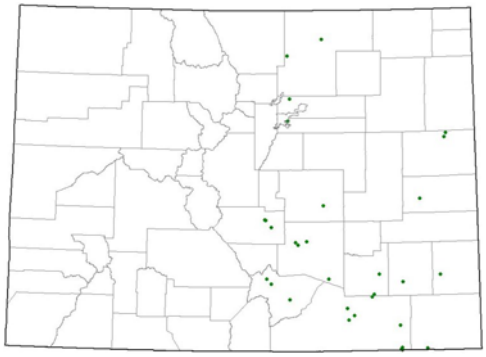
Look Alikes: The small stature, early blooming period, and heterophyllous leaves distinguish *Asclepias uncialis* ssp. *uncialis* from the sympatric and similarly small-sized *A. pumila*, which has white flowers, blooms from July to September, and has only filiform leaves (Locklear 1991). The low-growing *A. involucrata* may also be found in the southern portion of the range of *A. uncialis* ssp. *uncialis*. It has greenish-white flowers, blooms later than *A. uncialis* ssp. *uncialis*, and has longer leaves that are uniformly lanceolate (Locklear 1996).

Phenology: *Asclepias uncialis* ssp. *uncialis* is the earliest blooming milkweed in the Great Plains (Great Plains Flora Association 1986) although its flowering period can potentially overlap those of a few other species in its range (e.g., *A. asperula*, *A. speciosa*, and *A. involucrata*). In Colorado, flowering begins in late April and extends to the end of May. The small population in Weld County, Colorado, that did not flower in the dry spring of 2006 was observed flowering in early August of the same year after some substantial summer rains.

Habitat
Typical habitat for *Asclepias uncialis* ssp. *uncialis* is level to gently sloping terrain without notable micro-topographic features. Although plants are often found at the base of escarpments or mesas, the species does not occur on rock ledges or outcroppings, and is absent from highly disturbed habitats such as sand dunes, erosion channels, wash slopes, and badlands. Elevations of extant occurrences in Colorado range from 3,920-7,640 feet (1,190-2,330 m). Soils in the range of *A. uncialis* ssp. *uncialis* belong to orders characterized by dry, warm soils (Mollisols, Entisols, Aridisols, and Alfisols). *Asclepias uncialis* ssp. *uncialis* does not appear to have highly specific microsite requirements, and there is no evidence that *A. uncialis* ssp. *uncialis* is restricted to a particular soil type. Occurrences are known from soils derived from a variety of substrates, including sandstone, limestone, and shale, but are most often found in sandy loam soils. It does not occur in pure sand.
Asclepias uncialis ssp. *uncialis* is primarily associated with species typical of shortgrass prairie. Associated vegetation is comprised mostly of grasses, with forbs, shrubs, and trees typically comprising less than 15% of the total vegetation cover. Plants are typically found growing in open spaces between bunch grasses. Associated forbs are variable throughout the range, since many species found with *A. uncialis* ssp. *uncialis* in southeastern Colorado (e.g., *Melampodium leucanthum*) are near the northern edge of their distribution in that area (Locklear 1996). Although *A. uncialis* ssp. *uncialis* is often associated with Juniper Woodland and Savanna ecological systems, it is always found in the prairie or grassland components of these systems.

Distribution
Global Range: Historically, this species appears to have been known from two or three disjunct geographical areas: 1) the western Great Plains of eastern Colorado, northeastern New Mexico, and the adjacent Oklahoma panhandle; 2) central to southwestern New Mexico and scattered locations in Arizona; and 3) Sweetwater County in southwestern Wyoming. Some botanists consider the location of the Wyoming collection (*C.C. Parry #246*) to be an error in labeling and speculate that it may have come from northeastern Colorado (Fertig 2000, Fishbein personal communication 2004). Recent observations (i.e., those less than 20 years old) are confined to the first two areas mentioned plus a few observations in central New Mexico. Based on collection location and frequency, the range of the species appears to have contracted in northeastern Colorado since the mid to late 1800's.

Colorado State Range: Estimated range is 71,964 square kilometers (27,785 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences. There is potentially about 40,000 square miles of habitat in eastern Colorado (although perhaps as much as 50% of this area is no longer suitable habitat), roughly 45% of the total potential range of the species. The current known distribution of *Asclepias uncialis* ssp. *uncialis* forms an arc along the flank of the Southern Rocky Mountains from northeastern Colorado to southwestern New Mexico and adjacent southeastern Arizona. Currently known from nine Colorado counties (Las Animas, Weld, Kit Carson, Huerfano, Pueblo, Otero, Prowers, Fremont, and El Paso), and historically known from at least five additional counties (Baca, Bent, Washington, Cheyenne, and Denver). Occurrences are primarily in southeastern Colorado.



Threats and Management Issues

The primary threat at this time is considered to be agricultural development. It is not known if all of the occurrences are or are not threatened by these activities. In general, *A. uncialis* ssp. *uncialis* habitat, shortgrass prairie, is threatened by extensive human alterations for agricultural, residential, and recreational uses. Specific threats to extant occurrences include: recreational use, agricultural use, and military tank traffic. Based on available information, there are several threats to the persistence of *A. uncialis* ssp. *uncialis*. In order of decreasing priority, other threats are population limitation by unknown biological requirements, altered disturbance regime, habitat loss, spread of exotic species, and global climate change. A lack of understanding of population trends and habitat conditions for *A. uncialis* ssp. *uncialis* , and the lack of knowledge about its life cycle, population extent, and demographics also contribute to the possibility that one or more of these factors will threaten the long-term persistence of the species (Decker 2006). Locklear (1996) identified several patterns exhibited by *Asclepias uncialis* ssp. *uncialis* that are of concern: 1) *A. uncialis* ssp. *uncialis* is often not found at historical sites that retain native vegetation. In these cases, absence of *A.uncialis* ssp. *uncialis* may be due to causes peculiar to the biology of *A.uncialis* ssp. *uncialis*, instead of habitat degradation, 2) Most of the known populations are small, discrete, and isolated from each other. Large areas of intervening, apparently suitable habitat are not occupied. Gene flow between these isolated populations is unlikely, and may lead to a decline in species viability over time, and 3) *A.uncialis* ssp. *uncialis* exhibits extremely low rates of sexual reproduction, perhaps even lower than is characteristic of the genus. Although known populations are exposed to grazing, potential recreational use and development, and military training maneuvers, the degree of threat from these disturbances is not known.

References

Decker, K. (2006, April 24). Asclepias uncialis Greene (wheel milkweed): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/asclepiasuncialis.pdf [March 2006].

Fertig, W. 2000. *Asclepias uncialis* State Species Abstract. Wyoming Natural Diversity Database, Laramie, WY. Available .

Great Plains Flora Association. 1986. Flora of the Great Plains. University of Kansas Press, Lawrence. 1402 pp.

Kartez, John T. 1994. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland. Second edition.

Locklear, J. H. 1991. Status of Asclepias uncialis in eastern Colorado and northwestern New Mexico. Unpublished report prepared for the Nature Conservancy Colorado Field Office, Boulder, CO.

Locklear, J.H. 1996. The biology, Ecology, and Conservation needs of Asclepias uncialis in Colorado. Unpublished report prepared for the Colorado Natural Areas Program, Denver, CO.

Weber, W. and R. Wittmann. 2001. Colorado Flora: Eastern Slope. Third edition.

Zimmerman, D. 1993. More on *Asclepias uncialis*. Native Plant Society of New Mexico Newsletter 18(3):11.

Version Date: 12/20/2007

State Name: *Nuttallia chrysantha* (golden blazing star)
Global Name: *Mentzelia chrysantha* (Gold Blazing Star)

Taxonomy
Class: Dicotyledoneae
Order: Violales
Family: Loasaceae

Taxonomic Comments: Listed as *Nuttallia chrysantha* in the Colorado Flora Eastern Slope (Weber and Wittmann 2001). The difference between *Mentzelia chrysantha* and *M. reverchonii* is subtle, and they may actually be the same species (personal communication Tass Kelso 2006).

Ranks and Status
Global Rank: G2
State Rank: S2
Federal Protection Status: BLM Sensitive Species
State Protection Status: None

Description and Phenology
Non-Technical Description: *Mentzelia chrysantha* is a biennial or monocarpic perennial. In favorable years, it can complete its lifecycle in two years, but it can persist for several years as a rosette awaiting a favorable year. After it bolts and flowers, the plant dies. The plant has thick, erect, mostly unbranched stems, 2 to 6 dm tall. The leaves are 2 to 15 cm long, elongated (ovate-lanceolate to ovate), and sinuous-dentate (Spackman et al. 1997). The leaves, stems, and fruits have a dense covering of hairs. *Mentzelia chrysantha* produces numerous bright lemon yellow or golden yellow perfect flowers with 10 petals (Spackman et al. 1997). There are 50 to 80 seeds per capsule (Harrington 1954). The seeds are very narrowly winged, with a papillose seed coat (Weber and Wittmann 2001). The characteristics of the seed coat are generally regarded as being of great taxonomic value in *Mentzelia* (Hill 1976). For identification, the most up-to-date key available is that of Weber and Wittmann (2001), which includes a couplet that can distinguish *Mentzelia chrysantha* from *M. reverchonii*. This key and the descriptive information in Spackman et al. (1997) are the two best tools for diagnosing *M. chrysantha* in the field (Anderson 2006).

Diagnostic Characteristics: Collections of *Mentzelia chrysantha* with mature fruit should be made to verify any new occurrences, as long as the occurrence is large enough to accommodate a collection (as a guideline, at least 25 plants). The seeds of *M. chrysantha* have narrow wings and the seed coat is distinctly papillose. Flower color and date of collection should also be recorded. *Mentzelia chrysantha* has golden yellow flowers (the flower color may pale as the flowers dry) and blooms from July to early September (Spackman et al. 1997).

Look Alikes: Weber and Wittmann (2001) distinguish *M. reverchonii* from *M. chrysantha* using seed characteristics. *Mentzelia reverchonii* has broadly winged seeds that have few papillae on the seed coat while the seeds of *M. chrysantha* have narrow wings and are

distinctly papillose. However, these characters are subtle and variable, and make it difficult to identify plants in vegetative or flowering stages. In the rosette stage, *M. chrysantha*, *M. reverchonii*, *M. decapetala*, and *M. nuda* cannot be reliably distinguished (Anderson 2006). *Mentzelia nuda* is found with *M. chrysantha* at some locations. *Mentzelia nuda* has cream-colored flowers and blooms in June while *M. chrysantha* has golden yellow flowers and blooms from July to early September (Spackman et al. 1997).

Phenology: The seeds of *Mentzelia chrysantha* germinate in the early spring, or in late summer during a wet monsoon year. *Mentzelia chrysantha* is in flower through most of the late summer months, during which it bears numerous flowers in a tall inflorescence (Anderson 2006). Plants are in bloom from July to early September, and they are in fruit from late August into September (Spackman et al. 1997). Flowers open at 5-6 p.m, and close just after dark. Seeds are dispersed in the fall and winter. Dead stalks with dehisced fruits remain erect through the fall and into winter (Anderson 2006).

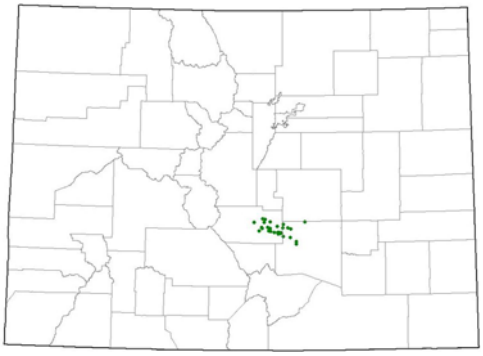
Habitat

Mentzelia chrysantha is typically found on barren slopes and road cuts of limestone, shale, or alkaline clay. The habitat of *M. chrysantha* consists of moderately disturbed, wasting slopes such as those above the Arkansas River. Slopes are usually moderately steep in the shale barrens; no particular aspect is favored. *Mentzelia chrysantha* occupies slopes and road cuts, where it grows prolifically and is often the only plant species growing in large numbers. *Mentzelia chrysantha* is found on a variety of geologic formations, mainly marine deposits from the upper (late) Cretaceous period. *Mentzelia chrysantha* is found primarily on the Smoky Hill member of the Niobrara shale, which is widespread throughout the middle Arkansas Valley, especially in the vicinity of Florence. The Smoky Hill member includes seven subunits that vary greatly in texture and color (may be olive black, yellow-brown, olive gray, pale yellow, or yellow gray). Coarse-scale vegetation types in which *Mentzelia chrysantha* is found include pinyon juniper-woodland and juniper woodland communities. While a few occurrences have actually been documented in pinyon-juniper woodland vegetation, the most commonly associated species are *Frankenia jamesii* and *Atriplex canescens* (Anderson 2006). *Mentzelia chrysantha* is also often associated with other rare plants such as *Parthenium tetraneuris* and *Mirabilis rotundifolia*.

Elevation Range Feet: 4,440 - 6,520
Elevation Range Meters: 1,353 - 1,353

Distribution

Global Range: Colorado endemic (Fremont and Pueblo counties). Estimated range is 1,373 square kilometers (530 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences.



Threats and Management Issues

Residential development is considered to be the primary threat to the species at this time. Other threats include commercial development, mining, recreation, right-of-way management, exotic species invasion, grazing, effects of small population size, climate change, and pollution. Fremont County is among the fastest growing counties in the United States, and low-density development is proceeding rapidly throughout the Arkansas Valley. Many of the known occurrences are located in highway right-of-ways where they are at risk from weed invasion and management (Anderson 2006).

References

Anderson, D.G. (2006, July 3). *Mentzelia chrysantha* Engelmann ex Brandegee (golden blazing star): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/mentzeliachrysantha.pdf [date of access].

Anderson, J. 1991. Specimen Collections at University of Colorado Herbarium, Boulder, Colorado.

Clokey, I.W. 1921. Plants collected in 1921 by Clokey were deposited at University of Colorado Herbarium, Boulder, Colorado.

Harrington, H. D. 1954. Manual of the Plants of Colorado. Sage Books, Denver, CO.

Hill, R.J. 1976. Taxonomic and phylogenetic significance of seed coat microsculpturing in Mentzelia (Loasaceae) in Wyoming and adjacent western states. Brittonia 28:86-112.

Jennings, B. 1993. Photocopy of field notes 1993-07-09.

Jennings, B. N.D. Photocopy of field notes, undated.

Jordan, Lucy. 1992. Listing priority number assignment form, USFWS.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land

Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program.

Weber, W. 1985. Specimen collections at University of Colorado Herbarium, Boulder, CO.

Weber, W. and R. Wittmann. 2001. Colorado Flora: Eastern Slope. Third edition.

Version Date: 02/28/2007

State Name: *Oxybaphus rotundifolius* (round-leaf four-o'clock)
Global Name: *Mirabilis rotundifolia* (Round-leaf Four-o'clock)

Taxonomy
Class: Dicotyledoneae
Order: Caryophyllales
Family: Nyctaginaceae

Ranks and Status
Global Rank: G2
State Rank: S2
Federal Protection Status: None
State Protection Status: None

Description and Phenology
Non-Technical Description: A perennial herb with round, densely soft-hairy, opposite leaves and trumpet-shaped magenta flowers in bloom in the summer (the flowers close by mid-morning). *Mirabilis rotundifolia* may be nearly glabrous to stiffly, densely hirsute.

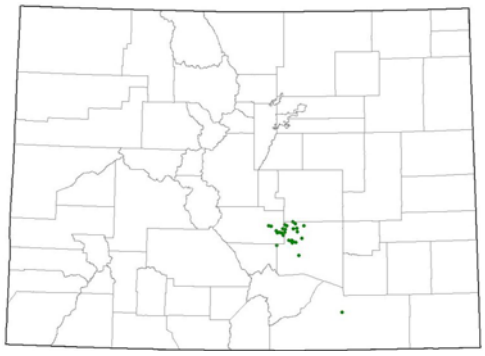
Look Alikes: *M. multiflora* is sympatric but is much larger, has glabrous and glaucous leaves. *Oxybaphus rotundifolius* generally has round leaves while *O. hirsutus* generally has oblong-ovate leaves (pers. comm. Minton 94-11-09). *O. rotundifolius* may be nearly glabrous to stiffly, densely hirsute. *O. hirsutus* is a buffalo wallow plant on the plains; it is not sympatric with *O. rotundifolius*. In vegetative state, *O. rotundifolius* is superficially similar to local species of *Penstemon* with glaucous, pointed leaves (pers. comm. Coles 1994).

Phenology: Flowering occurs from early to mid-June and the flowers open before dawn and remain open until approximately 9 a.m.). In 1990 the plants had not emerged by April 15, and were just greening up by mid-May. In 1989 they were too dry to be seen readily by mid July (Naumann 1990).

Habitat
Mirabilis rotundifolia (Oxybaphus rotundifolius) is generally restricted to outcrops of the lower shale unit of the Smoky Hill member of the Cretaceous Niobrara Formation. The plant community is sparse shrubland or woodland with a barren aspect. Frequent associates are James' frankenia *(Frankenia jamesii)* and oneseed juniper *(Juniperus monosperma)*. Elevations range from 4790 to 5610 feet (1460 to 1710 m).

Distribution
Global Range: Endemic to Colorado; known from Fremont, Las Animas, and Pueblo

counties. Estimated range is 3,732 square kilometers (1,441 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences.



Threats and Management Issues

Residential development is considered to be the primary threat to the species at this time. Highly threatened by residential and recreational development (Naumann 1990). Three sites are bisected by state highways and may be impacted by road use and maintenance. Predation by Hawk Moth Caterpillars (horn worms) may be a problem (pers. comm. Kelso 1996).

References

Coles, J. 1994. Personal communication about Rare Plant Guide Species.

Colorado Native Plant Society. 1989. Rare plants of Colorado. Rocky Mountain Nature Association, Colorado Native Plant Society, Estes Park, Colorado. 73 pp.

Kelso, T. 1996. Personal communication with CNHP staff.

Naumann, T.S. 1990 b. Status report for Oxybaphus rotundifolius. Unpublished report prepared for the Colorado Natural Areas Program, Denver, CO.

O'Kane, S. L. 1988. Colorado's Rare Flora. Great Basin Naturalist. 48(4):434-484.

Standley, P.C. 1909. The Allioniaceae of the United States with notes on Mexican species. Contributions from the US National Herbarium 12:303-389.

Weber, W. A. 1990. Colorado Flora: Eastern Slope. University Press of Colorado, Niwot, CO.

Version Date: 12/18/2007

State Name: *Oenothera harringtonii* (Arkansas Valley evening primrose)
Global Name: *Oenothera harringtonii* (Arkansas Valley Evening-primrose)

Taxonomy
Class: Dicotyledoneae
Order: Myrtales
Family: Onagraceae

Ranks and Status
Global Rank: G2G3
State Rank: S2S3
Federal Protection Status: USFS Sensitive Species
State Protection Status: None

Description and Phenology
Non-Technical Description: *Oenothera harringtonii* is an annual or biennial, perhaps occasionally a short-lived perennial. Plants have a stout taproot with one to five stems rising from a basal rosette. Plants stand 15-40 cm tall and support large white flowers with petals that are 2-2.6 cm long. The stems are yellowish-fawn color, usually with reddish-purple splotches. Plants flower from mid-May to June, with five to ten flowers per stem opening each day. Petals are white, fading to pink, and flowers have a heavy fragrance.

Look Alikes: Similar to *O. caespitosa* ssp. *macroglottis* whose range overlaps that of *O. harringtonii* in Fremont county. Because of their greatly different habitats they are rarely found growing together. One exception is along the Arkansas River between Parkdale and Canon City, where *O. caespitosa* ssp. *macroglottis* atypically occurs in a nonmontane habitat along the river. Intermediates have not been observed. The perennial *O. caespitosa* ssp. *macroglottis* has all basal leaves, notched corolla lobes, lower numbers of capsules per stem, and lower seed production. *O. caespitosa* ssp. *macroglottis* has a sweet fragrance as opposed to the strong "gardenia-like" fragrance of *O. harringtonii* (Wagner et al. 1995).

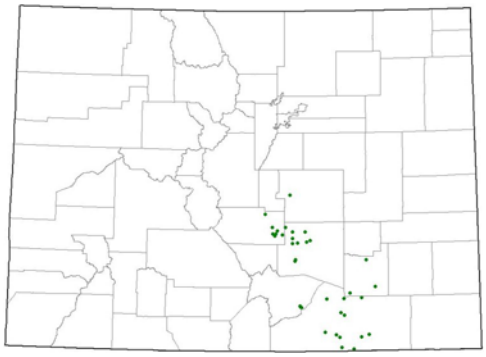
Phenology: Flowering mid May through June. Though *O. harringtonii* is typically annual, some individuals, especially from the southern part of the range, appear to overwinter and flower for at least a second season (Wagner et al. 1985).

Habitat

Oenothera harringtoni habitat is typically flat or gentle slopes in open shortgrass or saltbush communities. Plants are often found on compacted, silty clay soil, but may also grow on rocky, sandy, and silty loam soils. Substrates are often derived from shale and limestone formations, including the Niobrara formation, Carlile shale, Greenhorn limestone, Graneros shale, and Pierre shale formations. This species is known from an elevation range of about 4,600-6,100 feet.

Distribution

Global Range: Colorado endemic (El Paso, Fremont, Huerfano, Las Animas, Otero, and Pueblo counties). Estimated range is 15,693 square kilometers (6,059 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences. Probably in adjacent New Mexico (Wagner et al. 1985).



Threats and Management Issues

Residential development is considered to be the primary threat to the species at this time. Habitat loss due to urbanization, road development projects, and resource extraction activities, especially quarrying and surface mining, is a substantial threat to *Oenothera harringtonii*. Since several known occurrences are near highways, roadside maintenance activities, such as herbicide use, may impact the several known occurrences that are near highways. Recreational use of habitat is a threat to at least one occurrence at a Colorado state park. Invasion of habitat by non-native plant species is a potential threat throughout the range of this non-competitive species. Two classes of weeds pose substantial problems. Noxious weeds, such as field bindweed (*Convolvulus arvensis*) and jointed goatgrass (*Aegilops cylindrica*), and escaped non-native species used for agriculture and restoration, such as sweetclover (*Melilotus* spp.) and Mexican-fireweed (*Kochia scoparia*), have both been recorded at current occurrences. Livestock grazing, especially during flowering and fruiting periods, is likely to reduce the reproductive output of this species. This is a significant threat because *O. harringtonii* relies on seed production rather than vegetative reproduction to maintain its populations. Long-term sustainability of *O. harringtonii* populations is also jeopardized by declines in pollinator populations. The small size of many populations confers susceptibility to local extirpation from genetic, demographic, and environmental stochasticities (Ladyman 2005).

References

Ladyman, J.A.R. (2005, February 1). Oenothera harringtonii Wagner, Stockhouse & Klein (Colorado Springs evening-primrose): a technical conservation assessment.

[Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/oenotheraharringtonii.pdf [March 2006].

Wagner, W. L. 1983. New Species and Combinations in the Genus Oenothera (Onagraceae). Annals of the Missouri Botanical Garden 70:194-196.

Wagner, W.L., R.E. Stockhouse and W.M. Klein. 1985. The systematics and evolution of the Oenothera caespitosa species complex (Onagraceae). Monographs in Systematic Botany, Missouri Botanical Garden 12:1-103.

Version Date: 12/05/2007

State Name: *Oonopsis* sp. 1 (Pueblo goldenweed)
Global Name: *Oonopsis* sp. 1 (Pueblo Goldenweed)

Taxonomy
Class: Dicotyledoneae
Order: Asterales
Family: Asteraceae

Taxonomic Comments: Reserved for "*Oonopsis puebloensis*", an undescribed species in Colorado, being published by Greg Brown (University of Wyoming, see Brown 1993).

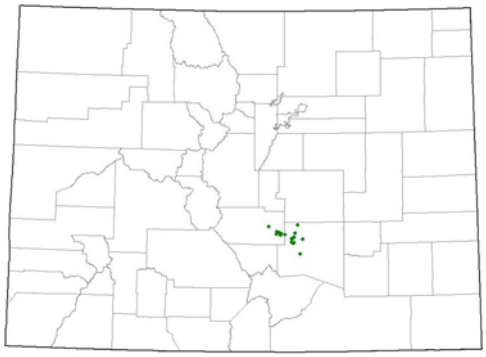
Ranks and Status
Global Rank: G2
State Rank: S2
Federal Protection Status: None
State Protection Status: None

Description and Phenology
Non-Technical Description: A low-growing perennial sub-shrub with yellow ray and disk flowers and strongly reflexed phyllaries, similar to *O. foliosa*, of which it appears to be a diploid ancestor (Brown 1993).

Look Alikes: *O. foliosa (H. fremontii, O. monocephala*) occurs in the same habitat as *O. puebloensis*. However, *O. puebloensis* is distinguished from *O. foliosa* by strongly pubescent phyllaries, leaves and peduncles, as well as its strongly reflexed phyllaries (pers. comm. Greg Brown 1996).

Habitat
Shale barrens of the Niobrara Formation between Canon City and Pueblo, CO.

Distribution
Global Range: An edaphic endemic found only on the Smoky Hill member of the Niobrara Shale Formation. Known from Fremont and Pueblo counties, Colorado. Estimated range is 905 square kilometers (349 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences. Recent unverified reports from El Paso County expand this range slightly to the north.



Threats and Management Issues

The major threats are from excavation by a local cement plant and development of the species' habitat for housing. These threats have been documented for the other rare endemic plant species inhabiting the same shale habitat. The shale substrates occur mostly on private land, much of it owned by a local cement plant and used for mining subsurficial limestone. In addition, residential development associated with the cities of Pueblo, Pueblo West, Penrose, Portland, Florence, and Canon City are expanding into the area. The Niobrara shale is exposed on the surface in a fairly restricted area west of Pueblo, and it is on these exposed surfaces that other endemic plant species occur. The cement plant is located in the area because of the ease of mining limestone from these exposed surfaces. Without protection planning, habitat for the rare plant species, including *Oonopsis puebloensis*, could become so restricted and fragmented that viable populations cannot be sustained.

References

Brown, G. 1996. Personal communication with CNHP staff.

Brown, G. K. 1993. Systematics of *Oönopsis* (Asteraceae). [Abstract.] Amer. J. Bot. 80(6, suppl.): 133-134.

Version Date: 12/18/2007

State Name: *Bolophyta tetraneuris* (Barneby's fever-few)
Global Name: *Parthenium tetraneuris* (Barneby's Feverfew)

Taxonomy
Class: Dicotyledoneae
Order: Asterales
Family: Asteraceae

Taxonomic Comments: Synonym is *Bolophyta tetraneuris* (Barneby) W.A. Weber

Ranks and Status
Global Rank: G3
State Rank: S3
Federal Protection Status: None
State Protection Status: None

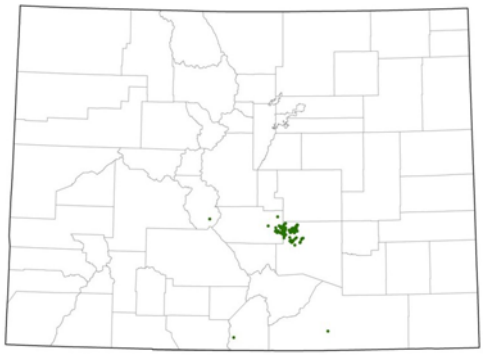
Description and Phenology
Non-Technical Description: *Parthenium tetraneuris* is an inconspicuous perennial that forms low mounds of leaves, 2-5 cm tall. White disk flowers bloom in May.

Look Alikes: This species is not likely to be confused with any other species in its habitat when they are in flower. However, in its vegetative state it is difficult to distinguish from *Eriogonum lachnogynum* and *Tetraneuris acaulis*.

Phenology: Flowers in May, fruit in late May and June.

Habitat
Found on tops of limestone and shale cliffs and bluffs, and in open pinon-juniper stands with very sparse ground-vegetation. Soils are derived from white shale (Peterson 1983). Grows on limestone and shale derived from the Niobrara Formation in communities composed of various mixtures of *Pinus edulis, Juniperus osteosperma, Cercocarpus* sp., *Artemisia* sp., *and Frankenia*. A disjunct population near Salida (Chaffee County) grows on alluvium of the Dry Union Formation (O'Kane 1988). The population in Costilla County grows on volcanic-derived soils (pers. comm. Jennings 1995).

Distribution
Global Range: Abruptly confined to exposures of gypseous shale (5,400 to 5,750 feet); it occurs in Pueblo, Fremont, Chaffee, Las Animas and Costilla counties; most occurrences are from Pueblo and Fremont county sites (ca. 179,000 individuals).



Threats and Management Issues

Threatened by housing and recreational development, mining for cement products, and off road vehicle use; effects of grazing not known (O'Kane 1988); road development and the expansion of the city of Pueblo are also significant threats (Peterson 1983).

References

Barneby, R.C. 1947. A new monocephalous Parthenium. Leaflets Western Botany 5:19-20.

Coles, J. 1994. Personal communication about Rare Plant Guide Species.

Jennings, W. F. 1995. Personal communication about Rare Plant Guide Species.

O'Kane, S. L. 1988. Colorado's Rare Flora. Great Basin Naturalist. 48(4):434-484.

Peterson, J.S. 1983 c. Status report on Parthenium tetraneuris. Unpublished report prepared for the Colorado Natural Areas Program, CO.

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program.

Version Date: 12/18/2007